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THE PROGRESS OF A DECADE.

THE REVIEW of May 15th, 1877, contained the description of a novel invention which had just been exhibited in Paris by an engineer officer in the Russian army. With the electric candle of M. Paul Jablochkoff 10 years ago a new epoch commenced, and it may be said that from its appearance dates our belief in the possibility of employing electricity with success for public lighting. In 1878 Paris was aglow with the electric light, and from this, the year of the International Exhibition, dates the birth of an industry which has seen its first decade. The electric lighting industry is not to be reckoned among the great ones, neither is it to be included among the least. Its growth has been dwarfed by obstructive legislation, and its development hindered by commercial mismanagement. Only now is it shaking itself free from the fetters that bound it; only now is it emerging from the purifying furnace of financial affliction.

On the appearance of the electric light in the gay capital, commercial panic spread like wildfire. A problem merely propounded was supposed to have been solved. Electricity was hailed as the illuminant of the future, while gas was relegated to a niche among the antiquities of the past. System after system was brought out and sold for ruinous sums. Men had gone mad, and in thousands they rushed eager to part with their hoarded gold for shares in each freshly published scheme. Our readers will doubtless have cause to remember this period. Nothing less than a revolution in economy was promised by each new inventor. Inaugurated in the evening with fine speeches and magnificent dinners the gentlemen of the daily press listened to glowing accounts of prospective results. In the morning the citizen read their reports born of the fumes of champagne and fabricated from materials visionary as the smoke clouds of their cigars.

And so companies were formed, and in due course directors had to meet shareholders face to face. In some cases clever financing was made to show fictitious stability, though in most instances disquiet was lulled to rest by specious statements regarding the advertisement expenses incidental to the nursing of a new industry. Of course the company would pay, who doubted it? but in the meantime they must show what they can do, large dividends necessarily following the appreciation of a grateful public. Their light gleamed in public places, and everyone would admit that it was the steadiest and the simplest. Indeed, the comparison with that of other companies had only to be made to show that *theirs was the business that would survive.* The shareholders were pleased, they had confidence in their board, they left the meeting chuckling over big dividends and prospective riches in the near future—to wait for the appreciation of a grateful public which never came.

At length the storage battery made its appearance, and a fresh impetus to speculation was given. Gas shares went down, electric lighting shares went up. The provision for storage, the one thing necessary to render electric lighting as reliable as gas lighting, had been obtained. It was determined that the foul breath of burning hydro-carbons should be breathed no longer, and schemes were at once set on foot to supply electricity for domestic lighting on a grand scale.

The history of these schemes is well known to our readers, and it would be hard to say who were to blame for all this misleading of the public. For our own part, we believe the guilt lay mostly at the doors of men who were as unpractical as they were enthusiastic. Among the men most dangerous at all times are enthusiasts. Working quietly in their laboratories, coming in contact with the poetic side of nature, they seem to have on the slightest occasion their imaginations fired and their heads forsaken by reason. To these men nothing was impossible. One-hundredth part of the idiotic twaddle which they mouthed to appreciative audiences could not be reported in a volume of our paper. Resulting from the possibility of storage, electricity was to be delivered to each householder, in a veritable magic-box, with his milk in the morning. Power could be transmitted electrically, and so factories were to disappear from the face of the earth. The weaver—poetic thought—would ply his loom in his own cottage by power supplied electrically from machines placed in the bowels of the earth, and driven by engines in the coal mines. Yes; the electro-motor had dealt its death blow to vandalism, and green trees and waving corn fields would soon take the place of blackened country and stunted vegetation. It was all very fine and large; it was poetic; it read like a fragment torn from the page of mediæval romance; but, alas! it was also—bunkum. The public believed it, as they will believe anything backed by authority. The knowledge of their advisers could not have been derived from the world of experience, but that did not matter. They had listened, they had faith, they had put their money down, and—they lost it. We say again to our readers, as we have said many times: beware of enthusiasts. Enthusiasm is not dead. The same advisers are at work still, though their attention has been transferred to something else. They are still twaddling, still enthusing, but they have found a new panacea, and are working it as vigorously as they did the other.

The electric industry, then, has had much to contend with. It has had from its commencement an uphill path, but, notwithstanding, it has in ten years reached a high state of development. The new light has not supplanted gas, nor, considering the question from a calmly philosophic point of view, are there any reasons to believe that it will. But side by side with that of gas the industry flourishes, each illuminant having its own place and sphere. Electricity has not supplanted steam on railways, nor is there any likelihood that it

will. But there is every reason to believe that in many instances electrically-worked tram lines will take the place of those now worked by animal power. The weaver is pretty much in his former condition, save that weaving sheds are lit electrically, and he works with a pure light in a pure atmosphere. General lighting from central stations has not made much progress, but there are hopes that in a limited sense this will prove in future a fruitful branch. In several instances electricity has been usefully applied for the transmission of power, and with success. Indeed, although there were not wanting those who, adopting a policy quite opposite to that of the enthusiasts, poohpoohed the whole thing, at the end of 10 years we find very substantial progress made.

The use of electricity is extending, and so far as we can judge the extension will continue. Though the competition in prices is remarkably keen, a firm business has been established. On all sides there are not wanting evidences that the days of panic and instability are past, and that the days to come are hopeful ones for the electrical world. Ten years ago we expressed our belief that gas was scarcely likely to be superseded by the electric light, and once more we reiterate the same belief. "It has almost invariably been the practice," we wrote in our leader of June 1st, 1877, "when a new invention is brought forward which possesses striking points of novelty, to prognosticate a splendid future for it, and the revolutionising of the existing means of producing that which the new invention promises to do in a far better manner. Without going so far as this, it is not prophesying too much to say that, with proper management and in proper hands, the invention of M. Jablochkoff will go very far towards proving the entire practicability of the electric light for general lighting purposes." Our prediction has been completely fulfilled, and the practicability of the electric light proved long ago. That the sphere of its application is limited none will doubt, but few would care at present to define its limits. In 10 years many changes have taken place, and these may have been in several ways unfortunate years. But if the past is dark the future is bright, and we think we have every reason to be proud of the progress of a decade.

CARRYING THE WAR INTO THE ENEMY'S CAMP.

A NOVEL item of news comes from America—whence many a novel thing has come before. At Charleston, in South Carolina, the rivalry between the gas company and the company which lights by electricity has reached such a pitch that it would seem to be a duel to the death. Nothing but extermination of the other will satisfy the gold-thirstiness of either combatant. Whether it will be a parallel case to that of the Kilkenny cats or not—whether or not, that is to say, they will so cripple each other that neither will be able to continue its existence—is a question which time must settle. Meanwhile, the strange contest wages fast and furious. Not content with opposing the virtues of its own beloved gas to the glaring, ghastly gleam of the electrical arc, the gas company has taken a bold step by announcing that it will erect an electric lighting plant—with the intention, no doubt, of supplying all who may desire that form of illumination with the current for electric lighting. This is a master-stroke of policy, and one difficult to surpass, one would think: it has its analogues in the proceeding of the debater who figuratively cuts the ground from under his opponent's feet, and in the action of the brilliant general who attacks the enemy within the walls of that enemy's most redoubtable stronghold. But, strangely, the electric company does not confess itself outwitted or in any degree beaten. It shows a bold front, and uses its utmost endeavour to keep abreast with its fellow-contestant in the race for fame—and for orders. It opposes still its light pre-eminent to the glimmer of the gas-jet, and challenges the other to do its best—or its worst—with its new weapon. But this is not all. The gas company performed a master-stroke, seemingly; but the counter-thrust is more brilliant still. Says the electric lighting company to the people of Charleston, S.C.—"To all whom it may concern! We, the Electric Light Company, of Charleston, South Carolina, desire to make known that in addition to supplying the electric light in a manner that defies competition, however unscrupulous, we are now in a position to contract for the lighting of all streets, houses, works or premises whatsoever, by means of gas, and to carry out our contracts better and cheaper (in the long run) than any other person, party, firm, company or corporation can possibly do!" or words, no doubt, to that effect. The gas company invades the territory of its rival and offers to erect electric lighting installations; the electric lighting company retaliates by erecting gasworks and undertaking gas lighting installations. May the best man win, as all good sportsmen say; or, better still, may both win, for that is an aspiration by no means impossible of fulfilment. There is no doubt room for both, for Americans for the greater part have far too fine a commercial instinct to waste money in a futile competition provoked by pique, so that we may fairly hope to see the two companies doing good and useful work, if not each in its own exclusive sphere, yet doing good work in the main, and work that will be a benefit to the community.

It is impossible to read and talk and write of this continual progress and pushing on of the American in matters electrical, without at times experiencing the liveliest dissatisfaction at the sluggishness of our own ways and habits. Here we are in the year of grace and jubilee, eighteen hundred and eighty-seven, and not three installations of the electric light in our capital—still the capital of the world, it is consoling to reflect—of sufficient magnitude or importance to show an American visitor as proof of our enterprise and our skill! Electrical tramways, here in the home of the motor and the very nursery of electric traction theories, still things scarcely ever seen, things of which one occasionally hears vague whispers—"It is going to be!"—and little else. It is true that at last, on the tram lines running from Stratford to Manor Park, electric engines drawing passenger cars may be seen quietly progressing next Monday; but this will be absolutely the first commercial experiment in electric locomotion in the Metropolis. In America, on the other hand—well, we are almost weary of reiterating what has been done in America during the last two or three years. Suffice it to say, that there are no less than twenty-three electric lines there in actual operation, whilst perhaps another fifty are projected, with a reasonable probability of being set in motion within a few months. We know the reasons too well which retard us here in England; we have pointed them out over and over again. Legislation and lack of legislation, fraudulent enterprise and absence of enterprise altogether, are among the chief causes of our rearward position.

Lighting of Newspaper Offices.—The electric light, on the Sawyer-Man system, has been in use in the offices of the New York *Tribune* for two or three years; the managers are well pleased with the result so far, and are about to enlarge the installation.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 493.)

VOLTMETERS AND AMMETERS.—*Continued.*

Instruments with Electro-Magnetic Controlling Fields.—To avoid the error due to the use of permanent magnets, Messrs. Crompton and Kapp have introduced instruments in which the permanent magnet is replaced by an electro-magnet, the magnetising current being itself the current, or part of the current, which is to be measured. The electro-magnet is subject to so strong a magnetising force that it is practically saturated at the lowest reading required. As the current is increased the controlling field is not increased much, but the field due to the deflecting coil or strip increases in proportion to the current. In order to avoid the error due to persistent magnetism, the iron core is made very thin, and is, in fact, a few wires of soft annealed iron. In the Crompton-Kapp instrument at present in the market, the voltmeter and ammeter do not take the same form. The voltmeter has a pair of astatic needles mounted on a vertical arbor, with pivots and jewels. A controlling field is produced by two vertical electro-magnets fixed with their axes parallel to the arbor, and the deflecting coils are two similar coils without iron cores. The controlling and deflecting coils thus act on both needles. A fault in this form is that as the cores must be very strongly magnetised, a considerable magnetising force is needed, and the instrument, therefore, takes so much power to make it work accurately, that it gets hot. Instead of winding the active coils with German silver, the makers use copper, and put a resistance of German silver or platinoid in series with them. The question of winding with different wires to avoid heating will be discussed separately. The disposition of the deflecting coils is bad, as they take a great deal of power, and are so placed as to have comparatively little influence on the needle. The ammeter consists of two horse-shoe controlling magnets, arranged like two letters C, with their like poles put together. The needle is mounted with a cap, as in a mariner's compass, or, as the makers call it, "suspended." The deflecting field is the current, or part of it. This instrument has the drawback of being affected by a dynamo, even at a distance, as the field due to the coils is weak. Care must also be taken in leading a large current to and from it. To avoid any errors due to the field produced by the connecting wires, the makers send out a long piece of flexible twin cable with clips.

Mr. Crompton has lately made considerable improvements in these measuring instruments, his object being to use less power, and to get a stronger field, so as to avoid errors from external fields. His latest form resembles the ammeter just described, but it has only one electro-magnet, as this takes less power to give even a greater controlling field. The chief improvement is, however, in obtaining a very much more open scale, and in adapting the ammeters to read very large currents directly. The current is led in and out at the side of the instrument farthest from the needle, so that any error due to the leads is practically eliminated. The index, instead of reading over the scale in the usual way, passes under it and turns over on the other side. The scale itself is engraved on an annular flat strip, which is raised about an eighth of an inch from the dial to allow the index to pass under. The point of the index is thus directed towards the centre. This is of very doubtful advantage.

FIG. 10.—CROMPTON'S PATENT AMMETER.

These instruments, though they are modestly called "current and potential indicators," are very carefully calibrated throughout the scales, and the dials are specially engraved. Though in the Crompton-Kapp instruments the errors due to persistent magnetism are reduced as much as possible, such errors must always exist to some extent, as the rising and falling curves of iron do not coincide even at the greatest magnetisation.

Messrs. Paterson & Cooper and the Thomson-Houston Company in America have also brought out instruments on the same principle. In both these instruments the iron core is much too large and the resulting error from persistent magnetism is considerable.

Mr. H. Davies has brought out an ingenious instrument. The current to be measured passes round the coils of a horseshoe electro-magnet, between whose poles there is a double needle system. This consists of a thin soft iron needle and a thick but shorter needle fixed at right angles to it. The two needles are mounted on an arbor so as to turn freely. When the current round the electro-magnet is small, the long thin needle determines the position of the system, but, as the current increases, the long thin needle becomes saturated, and the short thick needle, becoming more strongly magnetised, overcomes it, and tends to set itself in line of the field. This instrument, having a very strong field of its own, can be used near a dynamo, but of course its persistent magnetism error is large. It is calibrated throughout its scale. It is made by Messrs. Woodhouse & Rawson—prices, £3 7s. 6d. and £4. Before using an instrument of any sort which depends in any way on soft iron it should be tested for difference in readings with a rising and falling current. The current may rise gradually or not, but the falling current must fall very gradually, otherwise the error may not show. The best way is to vary the current by means of a water resistance. Voltmeters made with soft iron should always have keys, which should be pressed at the moment when a reading is to be taken. An instrument which gives very different readings with gradually rising and falling currents will often read quite accurately with a key. The key has another advantage, it prevents the heating of the coils. In most cases it is not necessary to leave the voltmeter on continuously, and so the temperature error due to the heating of the coils by the current itself is generally of little importance. Messrs. Crompton & Co. provide their voltmeters with commutators. Most voltmeters should have commutators, because they not only serve the purpose of keys, but they also allow any error due to the external fields to be seen at once and eliminated. Of course some instruments cannot have commutators, and in that case the whole instrument should be turned round to eliminate the external field error. Persistent magnetism errors are generally of far greater importance in ammeters, because from the difficulty of making the connections, especially when large currents are used, the instruments are left permanently connected up. Ammeters should always have a short-circuiting switch. Even if the current is very large, so that it is difficult to short-circuit the ammeter completely on account of its low resistance, a switch that will reduce its current considerably below the normal will do. It may appear as if the writer overrated the importance of the magnetism error, but to show that that is not the case, he may mention that being once asked to check the calibration of an instrument, containing soft iron, he found it on an average 30 per cent. wrong

with a rising current, and the error went up to 70 per cent. with a current gradually falling.

Gravity Instruments.—The force of gravity is generally used in instruments for very exact work, as in the case of the various current weighing instruments, such as, for instance, that used by Lord Rayleigh, and in the various bifilar instruments. Sir W. Thomson has lately brought out a series, most of which are gravity instruments. These have lately been brought before the Philosophical Society of Glasgow, and as the paper is being reprinted it is unnecessary to describe the instruments here.

Mr. Miller has brought out an instrument in which a small needle of soft iron is mounted on an horizontal arbor. It is balanced so as to tend to hang in one position. The coil of wire is arranged so that when there is a current the needle is magnetised and tends to set itself according to the field. These voltmeters and ammeters are made by Messrs. Sharp and Kent.

Messrs. J. G. Statter & Co. make an instrument on the same principle. In theirs the needle is not fixed centrally, but is on a little arm, so that its movement is not one of pure rotation, but partly of translation, as the needle is drawn up into the coil.

In such instruments the error due to persistent magnetism is very troublesome, and it is best to use a key or short circuiting switch. The error can be reduced by making the needles very light; but when they are so made the friction of the pivots becomes relatively important. Persistent magnetism in this case shows itself in two ways, one of which is probably

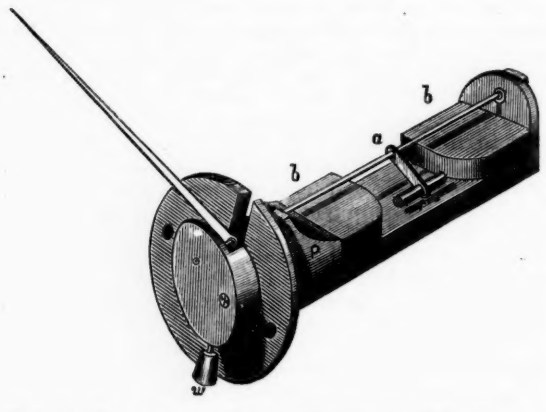


FIG. 11.—PLUG PART OF EVERSHED'S GRAVITY INSTRUMENT.

independent of the degree of saturation of the iron. The latter depends on the direction of magnetisation. When the current is increased the iron not only becomes more strongly magnetised, but the direction of its magnetisation is altered, and as the iron is already magnetised at a slightly different angle, there is a tendency opposing its being as strongly magnetised in the new direction as it would have been if it had been held in that position before the current was started. This persistence of direction of magnetisation may be easily tested. If, without altering the current, the index be moved some little distance, first, say to the right, and allowed to come back very gradually, it will come to one reading; if it be now moved to the left, and allowed to return in the same way, it will come to a different reading. This error may not always be corrected, even by the use of a key, as when the circuit is made the needle vibrates before settling down to its final reading. The vibration is not so free as when the index is moved by hand with no current in the coils; this is no doubt due to the damping effect of the angular persistent magnetism.

Messrs. Statter and Co. make their instruments to stand on a table, or to be carried in a wooden case. The latter is a very portable arrangement, as the instruments are small and light. They are then hung on gimbals inside the case, so as always to hang vertically. They also make them in another form to be fixed against the wall of an engine room. The prices are from £3 15s. to £6 10s.; the higher prices being for instruments in cases, or made to read over a large part of the scale with a small increase of electromotive force. This is very desirable for installation work. They cannot be used for alternating currents.

Mr. A. Wright has made an ammeter in which the repulsion of two iron cores, surrounded by one coil, is balanced by the action of gravity. He did not put it into the market because it did not read the same with a rising or falling current. This is to be regretted, as the fault is common to all instruments in which soft iron is used, the error being only a matter of degree depending on the magnetisation of the iron.

Messrs. Siemens have made instruments on the same principle, but the best known in this country is Schuckert's. The moving needle is a very light strip of soft iron. In the earlier forms, the force acting on the moving needle was increased by the attraction of a small piece of iron outside the coil. The General Electric Apparatus Company are agents for these instruments in this country. The prices are £3 3s. to £7 10s., according to the readings required; and they are advertised for use as high as 1,000 volts and 1,000 ampères. The appearance of these instruments appeals to the engineer more than to the optician, and this is in their favour.

FIG. 12.—STATTER'S ENGINE-ROOM VOLTMETER.

The writer, in conjunction with Mr. Evershed, made a gravity dynamometer, which did not depend upon a bifilar suspension. A coil is mounted on an arbor, which is made of German silver tube, with steel pivots let into the ends. This is mounted obliquely, and the centre of gravity is not in the axis of the arbor, so that the coil tends to set itself in one position. The moving coil is inside a pair of fixed coils. The coils are arranged to give a large deflection, the scale being spread out in the centre. Connection was made with the moving coil by means of mercury cups. This instrument reads over its scale with 13 watts. It was made as a wattmeter, the moving coil having the current. In the case of a voltmeter, the connections may be made by Helmholtz's arrangement; that is, by thin flexible pieces of copper foil or tinsel.

The Electrical Power and Storage Company make instruments in which the reading is taken by noting the weight needed to pull an armature off the core of an electro-magnet. A graduated lever has a rider which is pushed along till it pulls off the armature. This arrangement seems clumsy, and the persistent magnetism error must be very great if not carefully avoided, by pulling the armature off and replacing it

just before reading. There seems to be no reason why such instruments should not be very accurate. Of course reading them is troublesome; but they are essentially workshop instruments, as the forces dealt with are large, and there is nothing delicate to get out of order.

Messrs. Goolden & Trotter have lately brought out Mr. Evershed's gravity instruments. In these there is a coil, in the centre of which there is a sort of discontinuous core, consisting of two stationary pieces of soft iron, and one moving piece between them. These are mounted on a sort of plug which goes inside the coil, and is shown separately; r is the moving piece and b and b' the fixed pieces. w is a counterbalance weight tending to bring r into the position shown. When the iron is magnetised, r is moved laterally, so as to get into the stronger field, as b and b' are filed into curves, so that the field is stronger on one side. The plug and coil are mounted sloping, so as to make the instrument easy to read. It is very carefully calibrated throughout its scale. The voltmeter has a key. In the ammeters the lowest reading is about a quarter of the highest, and the error is very small with a falling current. Mr. Evershed anneals the iron very carefully, and removes the magnetic oxide by dissolving it, as he finds filing hardens the iron. The scale can be spread out where desired by altering the shape of the curves of b, b'. The instrument reads freely, as the pivots are jewelled, and the forces are great and the inertia and weight of the moving parts small.

(*To be continued.*)

ELECTRICITY ON THE "DOGALI."

THE Italian cruiser *Dogali*, at present the fastest sea-going war vessel in the world, which has been built and armed by Messrs. Sir W. G. Armstrong, Mitchell and Co., at their Elswick Yard, has been fitted by them with a very complete electric light installation.

In all some 150 16-C.P. 80-volt Swan incandescent lamps are employed for the internal lighting of the vessel, and there are also two search light projectors, made by Messrs. R. E. Crompton & Co., of Chelmsford, each taking 125 ampères with an E.M.F. at the dynamo of 80 volts, and giving a light of about 25,000 candle power.

The electric engine-room, which is situated over the main engines, contains three "Parsons" electric generators, supplied by Messrs. Clarke, Chapman, Parsons, and Co., of Gateshead-on-Tyne.

Each generator consists of a "Parsons" patent steam turbine, coupled direct to a shunt-wound "Parsons" dynamo machine, the two being on a single bed plate, and supplies a maximum current of 125 ampères with an E.M.F. of 80 volts.

The generators run at the very high speed of 9,000 revolutions per minute (150 per second), but notwithstanding this, there is no undue heating of the bearings, which are of special construction, so as to be self centreing, and as there are no reciprocating parts, and as everything is absoluely balanced and there is no thrust, there is very little wear or anything to get out of order.

Since the lubrication is forced and entirely automatic, the oil circulating continuously through the bearings, the generators will run for long intervals without attention.

The dynamo armature is of the drum type, with but one layer of wire upon it, the conductors being laid in longitudinal grooves cut in the built-up core.

As mentioned above, the dynamos are shunt-wound, but each is fitted with an electro-pneumatic governor, which controls the speed of the engine so as to maintain a perfectly constant E.M.F., however much the current, and consequently the load, is varied.

Owing to the high speed, there is very little copper in the armature, and the magnets being very small, the power expended in the magnet coils is exceedingly little; consequently, the dynamos have a very high efficiency.

The total weight of each complete generator, including engine, dynamo, governor, bed-plate, &c., is only 8 cwts., and the overall dimensions are 6 feet 3 inches long, 2 feet 3 inches high, and 12 inches wide. This extraordinary small weight and bulk in relation to power (10,000 watts) being, of course, largely due to the high speed attained.

One of the generators is capable of running all the incandescent lamps used for the internal illumination of the vessel, while the other two are employed to work the two search lights, each of which is supplied with current through a wire gauze resistance of ·2 ohm, in order to ensure the steadiness of the arc.

By means of a switch-board in the electric engine-room any one dynamo can be connected to any combination of circuits, but while this is effected, the dynamos are always quite distinct from one another, any connection between them through either the positive or negative conductors being impossible. Thus any mishap to the insulation of one dynamo or circuit cannot in any way affect the others. This switch-board was specially designed to meet these requirements by Mr. A. A. Campbell-Swinton, until recently electrical engineer to Messrs. Sir W. G. Armstrong, Mitchell & Co., under whose superintendence the whole of the installation has been carried out.

The vessel is also fitted with electrical arrangements for firing the guns from the conning tower on the bridge, it being possible to fire the guns either one at a time or in simultaneous volleys.

There is also electrical communication between the torpedo director stations on the upper deck and the discharging tubes beneath, so that the officer at the director can launch a torpedo with his own hand, though he is some distance removed from the discharging mechanism.

Both for the electric light and other circuits the ship is wired upon the system first introduced for ship lighting by Mr. Swinton, according to which the usual wood casing is entirely dispensed with, all the wires being lead-sheathed and fastened in place by stamped brass or cast-iron clasps, and the joints made in cast lead boxes, rendered watertight by being filled in with cement.

This arrangement presents a very neat appearance, as the wires can readily be bent to meet the exigencies of their position, and when painted are scarcely noticeable.

The *Dogali* is the fourth large vessel which Messrs. Armstrong have wired on this system, and there are four other cruisers besides a torpedo boat in progress.

In every case the lead-sheathed wire and cable has been supplied by the India Rubber, Gutta Percha and Telegraph Works Company, Limited, Silvertown.

MODIFICATION OF JOUBERT'S METHOD OF MEASURING COEFFICIENTS OF SELF-INDUCTION.

By Prof. SILVANUS P. THOMPSON.

THE following is a *resumé* of the remarks made by Prof. Silvanus P. Thompson in the discussion at the Society of Telegraph-Engineers upon the recent paper of Profs. Ayrton and Perry.

The method of Joubert for measuring coefficients of self-induction differed from any of those mentioned in the paper of Profs. Ayrton and Perry, being based upon a measurement of the spurious or apparent resistance. Joubert employed an alternating current, such as is furnished by a Weber's rotating sine-inductor, having a known period of alternation. As is known, with currents varying in a sine-function of the time there is an apparent increase of resistance due to the self-induction, such that

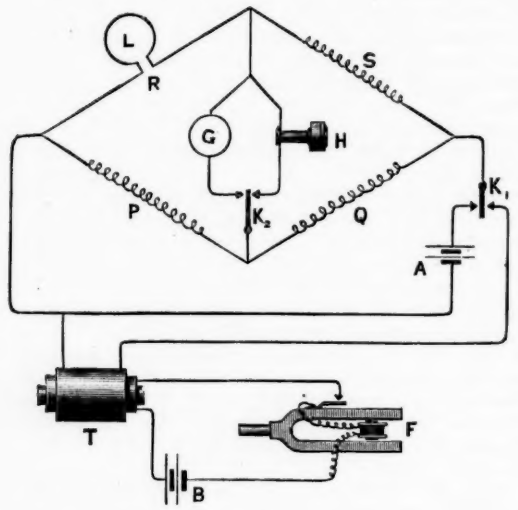
$$R' = \sqrt{R^2 + 4\pi^2 n^2 L^2}$$

where R' is the apparent resistance, R the real resistance, n the number of alternations per second, called

for brevity the frequency, and L the coefficient of self-induction.

Wishing to try this method some months ago, I devised a slight modification in which no apparatus is required beyond that which can be found in every physical laboratory, namely, a Wheatstone bridge, a small induction coil, and an electrically-driven tuning-fork having a known frequency.

The Fig. shows the arrangement of the apparatus. The coil having resistance, R, whose coefficient of self-induction, L, is to be measured, constitutes one arm of the balance, the other arms, S, P, and Q being ordinary inductionless resistances, and one of them at least, preferably S, capable of adjustment to any desired value.



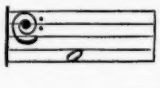
The usual battery, A_1, is supplemented by apparatus for producing alternating currents. A two-way switch, K_1, enables the experimenter to change from steady to alternate currents at will. The secondary wire of the induction coil, T, is connected through K_1 to the bridge, the primary wire is included, along with a local battery, B, and the interrupting tuning-fork, F, in a local circuit. In addition to the usual galvanometer, which will only serve for the steady currents, there must be provided either a sensitive electro-dynamometer, such as Bellati's, or else a receiving telephone, shown at H. A second key, K_2, is placed in this part of the bridge, an ordinary Morse key, having its front contact connected to H, and its back contact to G, answers perfectly.

To carry out the measurements, balance is first obtained using battery A and galvanometer G, in the ordinary way, thus giving as a first measurement the real resistance, R, of the coil or other apparatus that is being measured in the balance. K_1 and K_2 are then switched over so that the alternating currents are being used with the telephone receiver. The adjustable resistances are then altered until balance is once more obtained, that is to say, until the sound in the receiver is at a minimum, and the apparent resistance, R′, is noted.

The calculation of L from the formula for the apparent resistance is simple enough.

$$L = \frac{\sqrt{R'^2 - R^2}}{2\pi n}.$$

The electric tuning-fork which I have employed was one made by Kœnig, of Paris, adjusted to have a frequency of precisely 100 vibrations per second, its note being, therefore, about



but experience shows that a more convenient frequency would be 159·1, for this number, multiplied by 2π, gives 1,000. Were a tuning-fork of frequency 159·1 employed, the formulæ would become

$$R' = \sqrt{R^2 + (1000\ L)^2};$$

$$L = \frac{\sqrt{R'^2 - R^2}}{1000}.$$

THROUGH THE FOREST

(A HOLIDAY RHAPSODY).

By OUR EXTRA-SPECIAL CORRESPONDENT.

IT has long been an accepted axiom that the world knows not its greatest men, and it is an equally self-evident truth that these in their turn are but little, if at all, acquainted with many of the prettiest and most charming localities within the world in which they exist. Some of your subscribers with a musical turn of mind may connect the title of this article with *Der Friechutz* and Carl Maria Von Weber, others may wonder what on earth it has to do with electricity, and why it should appear in a technical journal; but the reasons will gradually dawn upon the reader as he proceeds. It has been definitely stated, on the indisputable authority of MM. Gilbert and Sullivan, that, taking one consideration with another, a policeman's life is not a happy one. This disclosure on the part of the Erckmann-Chatrian's of comic opera might be applied with increased force to the members of that profession which you, Gentlemen, represent; and it is on behalf of a discovery which I have made, or, rather, which has been confidentially and privately submitted to my notice and which should act as a panacea, at least, *pro tem*, for all the ills which beset the hard-worked and long-suffering electrician, that I venture to claim the indulgence of your readers.

The electrician has open to him, for the purpose of closer acquaintance with other representatives of his profession, the Society of Telegraph-Engineers and Electricians, the Dynamicable Association, and the newly-formed Electro-Harmonic Society. At the first of these he must be contented during the meetings to listen in silence to the reading of the papers, scientific or otherwise, which form the evening's programme, and but little time is afterwards left for social intercourse when the discussions which usually ensue are closed. These meetings, moreover, which are held fortnightly, occur during a portion of the year only, and that not the best for elevating the spirits or enlivening the mind.

The meetings of the Dynamicable Society, which was originally formed for the promotion of good fellowship amongst electric light engineers, are still less frequent, whilst its programme is made up of dinners and post-prandial discussions of a desultory character. Of the third institution, which has been promoted for the social needs of the profession, it is, perhaps, as yet premature to speak, therefore I leave it to answer for itself, but all three are mainly of service during the autumn and winter months of the year.

It is a matter for which the summer only is suited that I now desire to draw the attention of your readers. By a combination of circumstances, unfortunate or the reverse, as may hereafter appear, and which compelled me to remain behind when all London was travelling as fast as holiday time would allow to sniff ozone at the seaside, I was led to explore the happy hunting grounds, as yet almost untrodden by the foot of man, of Epping Forest. In the preface to the third edition of that admirable little book, "Walks in Epping Forest," by Percy Lindley, the writer observes: "Curiously enough, Epping Forest has been overlooked. The average educated Londoner knows it only by name. It was passed by as the damp home of doubtful gipsies, or the occasional retreat of holiday 'East-enders.' Epping Forest is too near. If it were fifty miles from town appreciative people would have discovered its beauties long ago; but the tardy recognition is coming."

Last Saturday morning, acting upon the invitation of Mr. Alex. Gordon, whose firm is not unknown to electric light contractors—as witness the incandescent lamps in the Holborn Restaurant, the Hôtel Métropole, the First Avenue Hotel, and other places in the metropolis—I proceeded from the Liverpool Street Station of the Great Eastern Railway to the Royal Forest Hotel, at Chingford, owned by Messrs. Alex. Gordon & Co., for the purpose of taking a seat in the hotel four-in-hand, and driving through a charming succession of rustic lanes, village greens, and the finest portions of the forest.

Chingford, I may here remark, is the centre of interest both of the Forest and the district, and the train service from London and back is good and frequent. Epping Forest, in fact, is readily accessible by rail from all parts of the metropolis.

Under the personal guidance of Mr. Gordon himself, and with Mr. Percy Lindley as a sort of *vade mecum* on all points of historical interest or of useful information, I set out for a three hours' spin on a dull but agreeable morning. To describe in glowing and eloquent language the lovely scenery through which I passed requires an abler pen and a more vivid imagination than I possess, for the situation of the place in which my daily work is done, a place which shall be nameless, is not the best spot in the world from whence to derive the inspiration necessary to convey to the reader a clear conception of the beauties of this earthly paradise, but I can state with truth that nowhere in England have I seen such a delightful series of rustic and woodland walks, such fine stretches of country and forest, and such magnificient views, as in this neglected and comparatively unknown portion of Essex, and it will be long before the pleasant reminiscences associated with the country which Mr. Lindley has so eloquently and minutely described fade from my memory. Driving a dynamo is, to me, a familiar occupation, but tooling along a four-in-hand seems to require such firmness of character, presence of mind (and, in case of accidents, absence of body), and concentration of thought, that I, who was honoured with a seat on the driver's left, felt positively lost in admiration of the man who handled his ribbons so dexterously, and who had such complete control of his fine team, that the most nervous occupant of a box seat could but feel that his safety was assured, come what might. My province is, however, only to show what temptations Mr. Gordon can place before the overworked professional man, to whom a complete change of even a few hours might be of immense benefit, and, after all, what is the use of temptation unless one falls into it? I have tried it, and can strongly recommend others to follow my example in this one respect, touching which the following information will be found serviceable.

The Royal Forest Hotel four-in-hand will, throughout the season, leave the Great Eastern Railway Station at Chingford on week-days at 10.45 a.m. and 3.30 p.m., and on Sundays at 10.55 a.m. and 3.55 p.m., for a two and-a-half to three hours' drive through the woodland and the charming country bordering Epping Forest.

The various drives have been arranged so as to include the finest portions of the forest, and all points of interest, and the routes have also been arranged so as to include, in addition to forest scenery and places of interest, the historical, antiquarian, and picturesque objects on the borders of the forest.

The Chingford to Chigwell drive, by Woodford, will afford an opportunity of seeing the church and old "Maypole" Inn at Chigwell, familiar to readers of *Barnaby Rudge*; the borders of Hainault Forest and the Roding Valley. The Chingford to Waltham drive, through the forest and back by its borders along the Lea Valley, will permit a visit to Chingford Old Church, one of the most picturesque remains in the county, and to the ancient Norman Abbey Church of Waltham Holy Cross. A third ride will be through the forest to the quaint market town of Epping and along the Old Cambridge Coach Road to the Lower Forest, and a fourth to Theydon Bois and the adjoining villages, through a succession of rustic lanes, village greens, and small woods bordering the east side of Epping Forest.

The coach is a new one, well found in every respect, and seats can be booked in advance on remittance of postal orders for the fares, particulars of which may be obtained on application to the Royal Forest Hotel, Chingford, Essex.

It is but natural that the excursionist upon his return to the hotel should feel, after a three hours' drive in the bracing atmosphere of the forest, as hungry as a hunter; and here, again, the allurements placed in the way of the ravenous traveller are too much to enable him to make more than a feeble attempt at resistance, even did he feel inclined to deny himself the desire of satisfying the inner man. He may now liken himself unto an incandescent lamp, for the vacuum with which he will find himself possessed (and the scientist knows that nature abhors a vacuum), will never allow him to go empty away, and he will find that the seductions of the interior of the Royal Forest Hotel are only equalled by its delightful surroundings. Were his appetite never so bad before starting, he will find himself transformed, by self-induction, into a trencherman of the highest efficiency, his internal resistance having become reduced to a mere fraction. The over-worked brain will become soothed under the softening spell of such seductive influences, and upon his return to town the wearied-out *voyageur* will find that "Nature's sweet restorer, balmy sleep," can no longer be fought against, and he will succumb to the inevitable. His waking thoughts in the morning, however, will assuredly convince him that he has at last hit upon a perfect cure for insomnia, that insidious curse of many a professional man's life, and which tends to hasten his end far more than all his hard work put together.

The position of the Forest Hotel renders it a residential health resort of the first order. It affords visitors, without much trouble or expense, an agreeable change at such a convenient distance from town that no particular preparation is needed, and the comforts of an elegant home at very moderate charges.

Standing on elevated ground, overlooking several miles of woodland, the Forest Hotel is close to the high referring point for Greenwich Observatory, from which point views are obtained of the Lea Valley, with Hertfordshire and half-a-dozen counties on one side, and the Thames Valley and Kentish Hills on the other. The hotel faces a noble grove of oaks, and is flanked by Queen Elizabeth's Hunting Lodge, with Connaught Waters in close proximity.

The hotel comprises about 60 rooms in all for visitors' accommodation. The set of private sitting rooms, decorated in the style of various periods and countries, such as the Watteau, the Renaissance, the Spanish, Indian, Japanese, and Dutch, form a unique feature. There are the usual adjuncts of a first-rate hotel, including private and public billiard rooms, and an extensive range of stable, providing saddle and carriage horses. Tennis courts, archery ground, and bowling green are now in course of construction in the newly-acquired grounds of the hotel. The recently erected Queen's Pavilion will easily accommodate no less than 750 persons at dinner, whilst minor halls will seat some 600 more.

En passant I will give my electrical friends an item of news which some of them may turn to account. Messrs. Gordon are seriously contemplating adding to the already great attractions of the hotel that of the electric light. How ravishingly beautiful would appear the Japanese, the Watteau, or the Æsthetic rooms under the mellow radiance of the glow lamp, and, in congenial companionship, what happiness there may be yet in store for those who choose to yield to the persuasive outpourings of my heated imagination! Thoughts of Pinsuti's "In this Hour of Softened Splendour" irresistibly crowd upon the brain and make themselves felt. But *verbum sap.*, and electrical men are certainly not unwise in their generation.

The French Ambassador, M. Waddington, at the celebration of the French National Fête at Chingford,

said that "he had experienced grateful rest and change that day by his walk and drive through the magnificent Forest of Epping, and he desired nothing better than to be amongst his compatriots in succeeding years, particularly if they celebrated their national fête amongst such salubrious and agreeable surroundings." "Atlas" in the *World* says:—"When I have found a good thing I am always anxious to share it with others; and I have found it of all places in Epping Forest. I have just come up from passing three charming days in that locality. At the Royal Forest Hotel, at Chingford, I found excellent cookery, good attendance and rooms, and the charges moderate. I can safely say I have never seen more exquisite woodland scenery in England; and never in England sojourned at a better managed or more thoroughly comfortable hotel. And all this an hour from Pall Mall!"

Mr. Gordon is naturally very proud of his charming retreat, and he thinks that for the summer meetings and excursions of scientific bodies it would form a most convenient and agreeable rendezvous. I coincide with him entirely in this respect, and would suggest that the idea is one which might be favourably considered by such societies as that of the Telegraph-Engineers and Electricians, the Dynamicables, and others. For the first mentioned, which will, I am informed, this summer celebrate in some way or another the jubilee of the electric telegraph, the idea of an excursion to Chingford would not be an unhappy one, as there will then probably be a number of colonial representatives in our midst, and in Epping Forest they would be enabled to catch a glimpse of some of the finest scenery in the Mother Country, and all within 30 minutes of the heart of the City.

If this somewhat wild, rambling, and incoherent composition should prove the indirect means of restoring the shattered nerves of any of the numerous and ever-increasing members of the profession to which I have the honour to belong, it will not have been written in vain. I shall doubtless have secured their everlasting gratitude, and with this I will remain content, for is not virtue its own reward? One word in conclusion; should any private individual or party be desirous of securing my services as conductor for the drive, and as technical adviser at the dinner table, terms and conditions, which must be treated in a strictly confidential manner, may be obtained on application to the extra-special correspondent of the ELECTRICAL REVIEW.

ON THE THEORY OF THE TELEPHONE: THE MONO-TELEPHONE OR ELECTRO-MAGNETIC RESONATOR.

By M. E. MERCADIER.

IN a former paper* on the theory of the telephone, I think I showed that the magnetic diaphragm of this apparatus is animated by two different kinds of movements which are superposed. One kind consists of the movements of resonance, which are molecular and independent of the outward form; it is these that enable the diaphragm to transmit and reproduce all sounds, a characteristic property that ought to have been expressed in the very name of the telephone by calling it pan-telephone. The others are harmonic movements and are transversal, corresponding to the fundamental sound and the harmonics of the diaphragm, and depending on its elasticity, form and structure; the former are prejudicial to the clear transmission of music and speech, for they alter the *timbre*, the harmonics only coinciding by the merest chance with those of the voice or instruments now in use.

In order to place beyond a doubt the existence and superposition of these two kinds of movements, I endeavoured to make the one predominate over the other at will in the same diaphragm. This was effected by means of the following method, which I invented in 1881, and have merely simplified since.

I. The diaphragm of any telephone is placed in conditions favourable to its vibrating transversely freely, and in such a manner as to enable the division into nodal lines corresponding to a determined given sound to be produced. For this purpose, instead of the diaphragm being fixed at its edges as is generally the case, it is simply placed as near as possible to the pole of the electro-magnet on a sufficient number of points of a nodal line.

If it is a rectangular diaphragm, it is placed upon two rectilinear supports coinciding with the two nodal lines of the fundamental sound. If it is a circular diaphragm, three apertures are made, from two to three millimetres in diameter at the angles of an equilateral triangle inscribed in the circumference which constitutes the nodal line of the first harmonic, and the disc is laid on three points of cork placed in a corresponding manner on a fixed straw and penetrating into the apertures.

This being done, let us introduce into the bobbin of the apparatus a series of currents of very low intensity, and gradually decreasing period, for example, proceeding from the emission of musical sounds before any transmitter whatever, either telephonic or radiophonic. Then the telephonic receiver, modified as already described, only vibrates appreciably under the action of the currents whose period is equal to that of the corresponding sound at the nodal line on which the diaphragm rests, a sound which I will term particular or special; it is no longer pan-telephonic, it is mono-telephonic, and may therefore be called a mono-telephone.

This result is not absolute. In reality, the diaphragm sounds some sub-harmonics of the special sound corresponding to the fixed nodal line; but their intensity is comparatively very low; and besides, the diaphragm reproduces somewhat lower or higher in period than the special sound, but the extreme interval between these sounds is very small, and does not generally exceed one or two commas.

These reservations are similar to those that have to be made in connection with resonators in acoustics. Likewise the kind of analysis that a mono-telephone makes of what we may term the electro-magnetic waves is analogous to that made of the sound waves by a resonator. In fact, if we communicate to them a series of successive or simultaneous waves of different periods, each of them selects in a certain degree that of the particular sound that corresponds to its geometrical form, and to the conditions in which it is placed, and greatly strengthens it. The mono-telephone might thus be termed an electro-magnetic resonator.

II. In the arrangement we have just described the transverse movements predominate, and it is easy to see the effect that they would have in an ordinary telephone; for if we try to reproduce by means of a mono-telephone articulate speech spoken into a transmitter, either we hear scarcely anything if the particular sound of the apparatus is not within the scale of the human voice (from the 2nd to the 4th C), or else, in the contrary case, we only hear sounds modified in quality and muffled articulations, the whole being drowned, as it were, in the sonorousness of the special sound every time it occurs.

But it is very easy to produce the opposite effect, viz., to make the molecular movements of resonance predominate over the transverse ones, and thus render the mono-telephone pan-telephonic, and make it reproduce all sounds with the same intensity and articulate speech with clearness.

To do this, it is sufficient to place obstacles in the way of the transverse harmonic vibrations by lightly fixing the edges or several points of the diaphragm; for example, by placing the fingers on it in a certain manner.

The most simple way of performing the experiment is as follows:—

We receive into the mono-telephone various succes-

* *Comptes Rendus*, Vol. CI., pp. 744 and 1,001, and the *Journal de Physique*, 2nd Series, Vol. V., p. 141.

sive or simultaneous sounds, among which is the special sound or articulate speech at about the pitch of this sound. We place our ear to the diaphragm; while it is a certain distance away, or at the most just brushing it, we hear only the special sound; but as we apply the ear to the diaphragm more closely, the special sound becomes weaker and weaker, and at last we hear all sounds with equal intensity and articulate speech without any appreciable alteration of quality. By this very simple method we cause the movements of resonance to predominate over the transverse ones, and give to the apparatus the pan-telephonic property possessed by the ordinary telephone with fixed diaphragm.

In a future paper I will return to the construction of the electro-magnetic resonator and its applications.

ON A UNIT OF ABSOLUTE TIME, ELECTRIC TIME STANDARDS AND VARIATION CHRONOSCOPES.

By M. LIPPMANN.

THE unit of time universally adopted, the second, undergoes only very slow secular variations, and can be determined with a precision and an ease which compel its employment. Still it is true that the second is an arbitrary and a variable unit—arbitrary, in as far as it has no relation with the properties of matter, with physical constants; variable, since the duration of the diurnal movement undergoes causes of secular perturbation, some of which, such as the friction of the tides, are not as yet calculable.

We may ask if it is possible to define an absolutely invariable unit of time; it would be desirable to determine with sufficient precision, if only once in a century, the relation of the second to such a unit, so that we might verify the variations of the second indirectly and independently of any astronomical hypothesis.

Now, the study of certain electrical phenomena furnishes a unit of time which is absolutely invariable as this magnitude is a specific constant. Let us consider a conductive substance which may always be found identical with itself, and to fix our ideas let us choose mercury, taken at the temperature of 0° C, which completely fulfils this condition. We may determine by several methods the specific electric resistance, ρ, of mercury in absolute electrostatic units: ρ is a specific property of mercury, and is consequently a magnitude absolutely invariable. Moreover, ρ is *an interval of time*. We might, therefore, take ρ as a unit of time, unless we prefer to consider this value as an imperishable standard of time.

In fact, ρ is not simply a quantity the measure of which is found to be in relation with the measure of time: it is a concrete interval of time, disregarding every convention established with reference to measures and every selection of unit. It may at first sight appear singular that an interval of time is found in a manner hidden under the designation *electric resistance*. But we need merely call to mind that in the electrostatic system the intensities of the current are speeds of efflux and that the resistances are times, *i.e.*, the times necessary for the efflux of the electricity under given conditions. We must, in particular, remember what is meant by the specific resistance, ρ, of mercury in the electrostatic system. If we consider a circuit having a resistance equal to that of a cube of mercury, the side of which = the unit of length, the circuit being submitted to an electromotive force equal to unity, this circuit will take a given time to be traversed by the unit quantity of electricity, and this time is precisely ρ. It must be remarked that the selection of the unit of length, like that of the unit of mass is indifferent, for the different units brought here into play depend on it in such a manner that ρ is not affected.

It is now required to bring this definition experimentally into action, *i.e.*, to realise an interval of time which may be a known multiple of ρ. This problem may be solved in various ways,* and especially by means of the following apparatus.

A battery of an arbitrary electromotive force, E, actuates at the same time the two antagonist circuits of a differential galvanometer. In the first circuit, which has a resistance, R, the battery sends a continuous current of the intensity, I; in the second circuit the battery sends a discontinuous series of discharges, obtained by charging periodically by means of the battery a condenser of the capacity, C, which is then discharged through this second circuit. The needle of the galvanometer remains in equilibrium if the two currents yield equal quantities of electricity during one and the same time, τ.

Let us suppose this condition of equilibrium realised and the needle remaining motionless at zero; it is easy to write the conditions of equilibrium. During the time, τ, the continuous current yields a quantity of electricity $= \frac{E}{R}\tau$; on the other hand, each charge of the condenser $= C\,E$, and during the time, τ, the number of discharges $= \frac{\tau}{t}$, t being the fixed time between two discharges; τ and t are here supposed to be expressed by the aid of an arbitrary unit of time; the second circuit yields, therefore, a quantity of electricity equal to $C\,E \times \frac{\tau}{t}$. The condition of equilibrium is then $\frac{E}{R}\tau = C\,E \times \frac{\tau}{t}$; or, more simply, $t = C\,R$.

C and R are known in absolute values, *i.e.*, we know that C is equal to p times the capacity of a sphere of the radius, l; we have, therefore, $C = p\,l$; in the same manner we know that R is equal to q times the resistance of a cube of mercury having l for its side. We have, therefore, $R = q\,\rho\,\frac{l}{l^2} = q\,\frac{\rho}{l}$; and consequently $t = p\,q\,\rho$.

Such is the value of t obtained on leaving all the units undetermined. If we express ρ as a function of the second, we have t in seconds. If we take $\rho = 1$ we have the absolute value Θ of the same interval of time as a function of this unit; we have simply $\Theta = p\,q$.

If we suppose that the commutator which produces the successive charges and discharges of the condenser consists of a vibrating tuning fork, we see that the

* In this system the measurement of time is not effected, as ordinarily, by observing the movements of a material system, but by experiments of equilibrium. All the parts of the apparatus remain immovable, the electricity alone being in motion. Such appliances are in a manner electric clepsydræ. This analogy with the clepsydræ will be perceived if we consider the form of the following experiment: two immovable metallic plates constitute the armatures of a charged condenser, and attract each other with a force, F. If the plates are insulated these charges remain constant, as well as the force, F. If, on the contrary, we connect the armatures by a resistance, R, their charges diminish and the force, F, becomes a function of the time, t; the time, t, inversely becomes a function of F. We find t by the following formula:—

$$t = \rho\,\frac{l\,s}{8\,\pi\,e\,s}\,\log\text{hyp}\,\frac{F_0}{F}$$

F_0 and F being the values of the force at the beginning and at the end of the time, t. The above formula is independent of the choice of units. If we wish t to be expressed in seconds, we must give ρ the corresponding value ($\rho = 1{\cdot}058 \times 10^{-16}$). If we take ρ as a unit we make $\rho = 1$, and we find the absolute value of the time by the expression:—

$$\frac{l\,s}{8\,\pi\,e\,s}\,\log\text{hyp}\,\frac{F_0}{F}.$$

We remark that this expression of time contains only abstract numbers, being independent of the choice of the units of length and force. s and e denote the surface and the thickness of the condenser: s and l the section and the length of a column of mercury of the resistance, R. This form of apparatus enables us practically to measure the notable values of t, only if the value of the resistance, R, is enormous, the arrangement described in the text has not the same inconvenience.

duration of a vibration is equal to the product of the two abstract numbers, $p\,q$.

It remains for us to ascertain to what degree of approximation we can determine p and q. To find q we must first construct a column of mercury of known dimensions; this problem was solved by the International Bureau of Weights and Measures for the construction of the legal ohm. The legal ohm is supposed to have a resistance equal to 106·00 times that of a cube of mercury of 0·01 metre, side measurement. The approximation obtained is comprised between $\frac{1}{300000}$ and $\frac{1}{200000}$. To obtain p we must be able to construct a plane condenser of known capacity; the difficulty here consists in knowing with a sufficient approximation the thickness of the stratum of air. We may employ as armatures two surfaces of glass, ground optically, silvered to render them conductive, but so slightly as to obtain by transparence Fizeau's interference rings. Fizeau's method will then permit us to arrive at a close approximation. In fine, then, we may, *a priori*, hope to reach an approximation of one hundred-thousandth of the value of $p\,q$.

Independently of the use which may be made of it for measuring time in absolute value, the apparatus described possesses peculiar properties. It constitutes a kind of clock which indicates, registers, and if needful, corrects automatically its own variations of speed. The apparatus being regulated so that the magnetic needle may be at zero, if the speed of the commutator is slightly increased, the equilibrium is disturbed and the magnetic needle deviates in the corresponding direction; if on the contrary the speed diminishes the action of the antagonistic circuit predominates and the needle deviates in the contrary direction. These deviations, when small, are proportional to the variations of speed. They may be, in the first place, observed. They may, further, be registered, either photographically or by employing a Redier apparatus, like that which M. Mascart has adapted to his quadrant electrometer; finally, we may arrange the Redier to react upon the speed so as to reduce its variations to zero. If these variations are not completely annulled, they will still be registered and can be taken into account.

As an indicator of variations this apparatus can be of remarkable sensitiveness, which may be increased indefinitely by enlarging its dimensions.

With a battery of 10 volts, a condenser of a microfarad, 10 discharges per second, and a Thomson's differential galvanometer sensitive to 10^{-10} ampères, we obtain already a sensitiveness of $\frac{1}{10000000}$, *i.e.*, a variation of $\frac{1}{10000000}$ in the speed is shown after some seconds of a deviation of 1 millimetre. Even the stroboscopic method does not admit of such sensitiveness.

We may therefore find, with a very close approximation, a speed always the same on condition that the solid parts of the apparatus (the condenser and the resistance) are protected from causes of variation and used always at the same temperature. Doubtless, a well-constructed astronomical clock maintains a very uniform movement; but the electric clock is placed in better conditions for invariability, for all the parts are massive and immovable; they are merely required to remain unchanged and there is no question of the wear and tear of wheel-work, the oxidation of oils, or the variations of weight. In other words, the system formed by a condenser and a resistance, constitutes a standard of time easy of preservation.

A New Telegraphists' Ailment.—A correspondent of the *Engineer* mentions that two telegraph operators, a male and a female, both otherwise healthy subjects, are being treated in Berlin for a newly-developed ailment, namely, the dropping off, one after another, of the finger nails. Prof. Mendel attributes this curious affection as the result of the constant jar caused by hammering and pushing with the finger ends in working the Morse system of telegraphy.

ELECTRO-HARMONIC PROGRESSION.

IT is not often that we relax from the earnest discharge of the stern labours which we have taken upon ourselves; and never do we do so, we hope, without adequate cause. A quite sufficient excuse, we contend, is afforded for departure from our usual course by the nature of the gathering which took place last Friday night in the Banquet Room of the St. James's Hall Restaurant in Regent Street. The members of the Electro-Harmonic Society met that evening for the third time to enjoy a feast of good things musical; but there was something distinctive about this third concert which prompts us to devote more of our space to it than we have given to the record of its two predecessors. It was the event of the season with the Electro-Harmonics: it was, in fact, the ladies' night. Only upon the rarest occasions—fortunately for them—do the fair beings who call grim electricians father, husband, brother, grace the assemblies of these latter with their gentle presence; and when they do the event deserves to be chronicled in an especial manner.

Beauty and talent were there in force: not all the talent confined to the one sex, either, if beauty was to the other. Many well-known faces met our view as we entered the room (for the arrangement was such that the audience looked towards the point of entrance and exit); and these were flanked and supported by other faces not so well-known, faces upon which the eye rested longer and would fain still rest. Charming young faces whose eager, smiling looks lit up the room and filled it also with a sweet peculiar music, silent, indeed, to the physical ear, but whose vibrations were all too surely communicated to the more sensitive organ in the masculine breast. Then there were the beaming countenances of—well, ladies not quite so young, but who still retained the charms which render the sex unceasingly attractive; and these lent to the gathering that pleasant, home-like character so dear to the hearts of those who, like ourselves, are unfamiliar with and uncomfortable amidst formal scenes and ceremonies. Genius was there, too, in the persons of more than one world-famous *savant*, whose inventions and researches have conferred unspeakable benefit upon admiring mankind.

Of the artistes we may say that they are all well and favourably known, and all justified the reputation which talent and honest effort have gained them. A perfect understanding existed between audience and artistes from beginning to end, and each body was appreciated by the other: from the melodious *terzetto* in the most musical of all tongues which opened the programme to the humorous "Good Evening" which brought it to a close all was truest harmony, as beseemed both the title of the givers of the concert and the sex of their guests. Applause of the most genuine kind greeted each performance, and in the several cases where *encores* were requested the enthusiastic calls brought graceful responses. We shall not attempt a critical examination of the programme, but may be permitted to enumerate what particularly pleased us. Mr. Arthur Thompson's fine tenor found ample scope for the exercise of its captivating powers in an aria by Handel, "Where'er you Walk," and it again charmed all hearers in rendering Berthould Tours' sweet setting of one of Longfellow's beautiful, simple songs, "Stars of the Summer Night." Mr. Thompson will perhaps forgive us for saying that we believe he would create a still more pleasing impression if he imparted a little more variety to his repertoire. Both his contributions on Friday were beautiful and were beautifully rendered; but so accomplished a vocalist scarcely does himself justice by adhering to music of a more or less uniform type. This by the way, however, and with the utmost good feeling. Miss Ethel Winn trilled forth a pretty invitation to the nymphs and shepherds, of whom—or at least of nymphs and enamoured swains, which means nearly the same thing, we believe—there were many present. Mr. T. E. Gatehouse's share in the programme took the form of the Adagio and Rondo from the 9th Violin Concerto

of De Beriot, and then Madame Florence Winn expressed her devotion to "Thee" in the tenderest of sweet breathings and in a manner which must have made that particular "Thee" the happiest of mortals had he been present. Mr. Frederick Bevan then told all—or as much probably as he cared to tell—about his fair love, how true and how fair and how sweet she was, and everybody believed that he meant what he sang and applauded him for his chivalry—and for his singing. A choice excerpt from Mendelssohn followed, by that clever young pianist, Mr. Alfred Izard, who, we must not forget to say, ably accompanied throughout. Of the "Two Spoons," described so quaintly by Mr. Herbert Schartau, we need only say that their queer proceedings excited the merriment of everyone. And there ended Part I. After an interval, which was well-employed in more ways than one, and during which a wonderful telephone, kindly set up by Mr. Fletcher, of the United Telephone Company, brought down from Heddon Street the weird strains of an equally wonderful cornet solo, played by Mr. Kingsbury of the Western Electric Company, Madame Florence Winn and Miss Ethel Winn gave some quite gratuitous advice to a young gentleman who, so they alleged, was being befooled by some fair "She" (not Mr. Rider Haggard's, we presume?) who could both false and friendly be. That's a kind of advice, we may inform those young ladies, which is rarely taken in good part, and we fear their warning tones went unheeded just where there was most need that they should be heard. Of Mr. Arthur Thompson's "Stars of the Summer Night" we have already spoken. How can we describe the piquant way in which Miss Ethel Winn declared she would be no submissive wife? She seemed quite determined upon the point; but when put to the test by an *encore*, she showed that she could be an anxious lover, if not a submissive wife, by singing most charmingly that half-petulant, half-lamenting, and altogether pathetic song, "Oh, dear, what can the matter be?" Mr. Gatehouse followed with a performance of Paganini's fantaisie *sur* "Mose in Egitto," for the fourth string only, and then Madame Florence Winn gave "Here's to the Year that's Awa'!" in brave style, and with quite a new reading of the last verse in honour of the—well, of a particular event in connection with Her Majesty's reign which is to be celebrated this year. Mr. Frederick Bevan had more to say about his love affairs, using as his medium this time the famous words of W. S. Gilbert, "Time was when Love and I were Well Acquainted." This pleased so much that Mr. Bevan was invited to sing again, and he retaliated with the mournful "Tit Willow," which, strange to say, moved the audience to laughter instead of to tears of pity. Mr. Herbert Schartau narrated the woeful history of the "Three Little Pigs" in such a touching manner that an irresistible call of *encore* went forth and he came back and sang of "Joshua" in his most comical vein. And then "Good Evening," and "God Save the Queen."

Everybody was pleased, and everybody hoped an equally enjoyable occasion might soon bring them all together again, or, if that might not be this season, that next year the committee may be prevailed upon to arrange for more than one Ladies' Night.

THE ROYAL JUBILEE EXHIBITION, MANCHESTER.

A MONTH having now elapsed since the opening of this exhibition, it is pleasant to notice that the electric lighting continues to give the greatest satisfaction, and that the working has been as free from faults and hitches as could be wished.

The arc lighting is certainly better than it was at the commencement, and the illumination of the grounds has been greatly improved. At the present time there are throughout the building and the grounds as many as 520 Brush lamps fixed, but certain alterations having to be made, the full number originally specified has not up to the present been fixed. In addition to the lamps recently erected in the lower grounds, it is intended to place a considerable number in the recreation grounds as soon as the arrangements for the public have been completed. It is to be noted that the Brush Company has an ample stock of lamps on the ground to meet all demands. There are sundry points in connection with the Brush arc installation to which we shall refer later on.

The change in the candle-power of the incandescent lamps in the "Victoria" and "Prince of Wales's" dining rooms has been made, and there are now 450 lamps of 8 candle-power, which give all the light which could be desired. In the part of the exhibition known as "Old Manchester and Salford" there are as many as 600 lamps of 16 C.P. distributed throughout the various shops and houses. The dynamos provided for the lighting of these two sections have considerable excess of power beyond the requirements of the exhibition itself, and a portion of the surplus power has been utilised for the supply of lights to the stands of exhibitors in various parts of the building. In this manner several smaller installations have been effected, branching from off the mains of the "Old Manchester" and of the "dining-room" sections; up to the present time over 500 lamps of 16 C.P. have been fixed, and in all probability this number will be very largely increased before long.

The lighting of the Fine Arts sections continues to be all that can be wished, and the engines and dynamos lent by Messrs. Mather and Platt, of Salford, for this portion of the electric lighting have done their work well. In our previous notice we only briefly referred to these, but we now give some details (for which we are indebted to Messrs. Mather and Platt) which will doubtless be read with attention.

Both engines and dynamos have been constructed by Messrs. Mather and Platt, of the Salford Ironworks, Manchester. The engines have been specially designed for electric lighting work, and embody several interesting and novel features. In their general arrangement, and in the method of driving, the requirements of a central station installation or a large mill installation have been specially held in view, where economy of floor space is usually of primary importance. When the engines are worked to their full power, and the dynamos replaced by the next standard larger size, the whole plant would be capable of supplying current for 4,000 lamps of 16 candle-power, while the total floor space occupied does not exceed 30 feet by 20 feet. Another essential condition of electric lighting engines is a sensitive, quick-acting automatic cut-off. This is accomplished by an entirely new form of cut-off valve, recently patented by Messrs. Mather and Holgate.

The engines are of the vertical high-pressure condensing type, with a single inverted cylinder 20 inches diameter and 30 inches stroke, intended to run at 120 revolutions per minute, and to work at a boiler pressure of 100 lbs., and under these conditions will each indicate about 200 horse-power. The two engines are entirely independent, each having a separate flywheel and independent off bearings, but they are connected together by a bridge to give access to the cylinders and valves. The cylinders, cylinder slide, and crank bearing pedestal are cast in one piece with the trunk or frame, which is of a box section closed entirely back and front but open at the sides. The form is very rigid, and looks massive and substantial in design; at the same time, as the frame casting is only $\frac{7}{8}$ths inch thick, it is actually not so heavy as it appears. The cylinder is fitted with a loose liner, which forms the steam jacket. The valve box is bolted on loose and has double slide valves so as to get straight ports from the valve box to the cylinder. In the main slide valves the ports are straight on the cylinder side, but the passages are obliquely directed within the block of the valve, so that the ports on the off side are curved, the edges being circular. The main valves are worked in the usual way with an eccentric on the crank shaft. The cut-off valves work on the back of main valves, with a reciprocating motion also derived from an eccen-

tric on the crank shaft. These valves have curved edges corresponding to the curvature of the ports of the main valves, and are carried on pivots fixed in the slide block. The cut-off valves can thus turn about an axis at right angles to the axis of the cylinder, in addition to their rectilinear recriprocating motion. The point of the stroke at which the steam is cut off depends upon the angular position of the cut-off valve, which is regulated directly by the governor through a suitable series of levers. The piston rod and crank pin are steel, and the connecting rod best hammered scrap. At the cross-head end the connecting rod is forked, and the wear taken up by a wedge and screw ; its length is three times the stroke. The crank is of steel, and balanced and covered with a cast iron shield. It is shrunk and keyed on to the shaft ; the crank pin is also shrunk in.

The shaft is 8 inches diameter, bossed up to 8½ inches for the flywheel, and at the crank end is carried in a bearing 15 inches long, and at the off end in an angle pedestal 12 inches long and 6½ inches diameter. The main bearing is adjustable both top and bottom, and at the sides by wedges and screws, so that the brasses can be fixed in any way while the engine is at work.

The flywheel is 12 feet diameter and 30 inches wide, and is prepared for two 13-inch belts. It was cast whole, split and bolted together at the rim, and held with bolts and shrunk hoops at the boss ; its finished weight is 5¾ tons. All the bearings, the eccentrics, crank pins, &c., are lubricated from one oil tank, to which the oil is pumped from a tank at a lower level into which it collects from the drippers. The cylinder is lubricated by Mather and Platt's improved sight feed lubricator requiring one plug valve only.

The air pump and condenser are of the ordinary vertical type fixed below the floor. The pump is single acting, 12 inches diameter 15 inches stroke, and is worked by a beam from the engine crosshead. Throughout all threads on bolts are fine pitch or gas threads, and in working parts have a nut of ordinary depth, locked with a thin one, and in addition have a split cotter through the end of the bolt.

The left hand engine drives two "Edison-Hopkinson" dynamos, both shunt wound, for an output of 105 volts, and 320 ampères at a speed of 750 revolutions per minute, equivalent to 500 lamps of 16 candle-power. These machines have a commercial efficiency of 93·3 per cent., and an electrical efficiency of over 95 per cent.

The right-hand engine drives two "Manchester" dynamos, compound-wound, for an output of 100 volts, and 400 ampères at a speed of 750 revolutions per minute, equivalent to 700 incandescent lamps of 16 candle-power. To provide for the loss of E.M.F. on account of the distance of the fine arts gallery from the dynamos, the engines are driven at a higher speed than that stated, with a corresponding increase of volts in the dynamos.

The efficiency of the Manchester dynamo is also very high. With the full load the electrical efficiency is 94·8 per cent., and the commercial efficiency 92·8 per cent. These dynamos, as also the Edison-Hopkinson, are driven direct from the flywheels of the engines with link belts. In order to increase the lap of the belt on the driving pulley of the dynamo, it is bent on the slack side under a loose pulley riding on a stud, carried on an arm, projecting from the dynamo bed.

The belts employed for driving the dynamo are worthy of notice ; as instead of having flat faces as is usual with link belts, the section is double concave, so that the pins are not bent as the belt is bent over the convex surface of the pullies.

As mentioned in our previous account, the Fine Arts Section consists of four circuits, two of which are 280 yards in length and two 350 yards, and the branches are so arranged that the alternate principals (each supporting 15 lights) are supplied from a separate dynamo so that the failure of any one dynamo can only affect the alternate principals in the circuit which it runs ; a further combination is obtained by each of the two engines driving one dynamo of the short section and one of the long section, the result being that the stoppage of either of the engines would only affect one half of the lights in each of the galleries. The arrangement of the circuits and their control is, of course, under the charge of the Manchester and District Edison Electric Light Company, which company is the sole contractor for the incandescent electric lighting of the exhibition.

As we have described one portion of what may be termed Messrs. Mather and Platt's exhibits, we now turn to their stand in the Machinery Annexe, where the application of electricity to another purpose than that of electric lighting may be seen. In this portion of their exhibit the special intention has been to show the applicability of electricity for the purposes of the transmission of power. At this stand is shown an electric singeing machine driven by a dynamo motor, and also a large 10-colour calico printing machine, also driven by a motor. This machine, which is worked by the Rossendale Printing Company, affords an excellent example of the value of the dynamo applied as a motor.

A large printing machine similar to the one exhibited, would be driven under ordinary circumstances by a double cylinder diagonal engine with cylinders 10 inches diameter, 12 inches stroke, running at about 180 revolutions per minute. The star wheel of the printing machine when printing at full speed runs at 12 or 13 revolutions only, it is therefore necessary to reduce the speed by gearing. But where a dynamo-motor is used in place of the steam engine, the speed of the motor must be much higher in order to obtain good efficiency without unduly increasing the size and cost of the motor. The motor employed at the Exhibition runs at 700 revolutions, hence the speed must be reduced in the ratio of 56 : 1. This is accomplished by a combination of belt and spur gearing. The dynamo shaft is fitted with a pulley 16½ inches diameter driving by means of a short belt on to a pulley 54 inches diameter. In order to increase the grip of the small driving pulley on the belt, a loose "jockey" pulley is employed. The jockey pulley runs loose on a stud fixed on an arm projecting from the dynamo bed and bears against the slack side of the belt. By an arrangement of worm and wheel the arm can be raised or lowered moving the loose pulley with it, and consequently increasing or diminishing the angle at which the belt is bent over it. By this means the surface of contact between the belt and the driving pulley can be increased, and the slack of the belt taken up, thus at the same time giving an adhesion equal to that of a long belt and providing means for taking up the slack as the belt stretches. The speed is further diminished by a train of two internal spur wheels and pinions. The combination gives an effective drive, occupying no more space than the gear for reducing the speed of a steam engine and under perfect control.

The printing machine is of Messrs. Mather and Platt's latest design for printing cloth up to 34 inches wide with from one to ten colours simultaneously at a speed of 30 yards per minute. The machine is fitted with traverse motion for the doctors, long rollers and steam drying. To work it at full speed from 15 to 20 horse-power is required. In order to set the pattern it is essential that the speed of the machine should be so under control that it can be made to "creep" round and can be stopped in a fraction of a revolution so as to enable the printer to see that the rollers, each printing one colour, are properly adjusted relatively to one another. With a steam engine this is effected by a throttle valve on the steam inlet, the valve spindle being fixed conveniently accessible to the printing. But a steam engine must have a flywheel, and the valves cannot be instantaneously closed, so that the machine cannot be stopped as quickly as might be desired. A dynamo-motor, on the other hand, having no dead points, requires no flywheel and the current can be instantaneously shut off and consequently the machine brought to a stand more rapidly than is possible with steam engine driving. The speed is regulated by a switchboard placed at one side of the

machine, at the printer's right hand, arranged to insert resistance in the circuit and so lowering the speed of the motor to any desired extent. The whole floor space covered by the motor, driving gear and resistance is somewhat less than that which a steam engine would take; a point of much importance in print works.

The current is conveyed to the motor from a generating dynamo by an insulated copper cable 45 yards in length, carried under the floor of the machinery annexe. The generating dynamo is also of the "Manchester" type, and is a similar machine to the motor, capable of generating 25 to 30 electrical horse-power at a speed of 950 revolutions per minute. It is driven by a double cylinder diagonal engine with cylinders 8 inches diameter 10 inches stroke, and running at 180 revolutions per minute, with a short belt driving on the same principle as that used with the motor.

In a large print works where there are a considerable number of independent machines, the advantages of a dynamo motor are very conspicuous. For in place of a separate small engine to each machine working necessarily with low steam pressure, often with considerable back pressure, and generating under conditions where high efficiency is impossible, a single high class engine can be used working under the most favourable conditions with high pressure steam, high expansion, proper automatic cut-off valves giving the highest efficiency. This engine would be employed to drive one or more generating dynamos (which might also be employed for lighting purposes), and from these cables would be taken to each independent machine worked by its own motor.

Such a system has, moreover, the advantage of avoiding the necessity of steam and exhaust pipes and drain pipes for the engines running throughout the building—a point of considerable importance when the operations carried on require great cleanliness.

The advantages of a dynamo-motor for similar purposes to that we have just described have been so often pointed out in these columns that it is hardly necessary to repeat them; we would, however, mention that where electric lighting plants have been established, the dynamo could be utilised in the daytime as a generator for the transmission of power, and further, that the power can be transmitted by means of insulated cables with a facility with which no other power can possibly be transmitted, and under circumstances where to obtain it, it would be necessary to lay down a complete steam plant or other source of power.

At the same stand is exhibited a small working model of the Newry and Bessbrook electric railway, and also an electric singeing machine, a description of which will appear in a later issue.

THE JUBILEE ILLUMINATIONS AT BATH.

NATURALLY enough, Mr. H. G. Massingham is not altogether pleased with the spirit in which the Corporation of Bath—or, rather, a section of that body—received his offer to illuminate the Guildhall, externally and internally, with the electric light during the Jubilee week. In a letter which he wrote to the Mayor, a few days ago, withdrawing his original offer, he states that he was not aware at the time he made it that it would have excited so much opposition. As the Council had practically declined to recommend the use of electricity, and it had been stated "that those citizens who are desirous of seeing the electric light introduced permanently into Bath, are now trying to get an experiment carried out at the expense of the ratepayers," he should, under such circumstances, be extremely reluctant to receive any payment, however small, from the public funds for lighting public buildings. He also found that many gentlemen supported Major Davis's view, as expressed at a meeting of the Jubilee committee, that electric arc lamps are a most objectionable form of illumination—an opinion which he hoped and believed they would admit to be erroneous after seeing one side of the market-place lighted by the system which he intended using. This "shot" of Mr. Massingham's has fairly hit the target, and the City Fathers are regretful now that they treated the favourable offer which was made them with such off-handed flippancy. Some, fearful, perhaps, for the continued supremacy of gas, pretended to look upon the proposal as a Grecian gift, but now that the offer has been withdrawn, there is a general consensus of opinion that to illuminate the Guildhall with the yellow and weakly rays which are usually characteristic of gas, would be the height of grotesqueness, when just opposite, the market-place is being rendered conspicuous by the brilliant blaze of electric arc lamps. The only way of preventing a fiasco, appears to be for the Corporation to seek the kind assistance of the gentleman whom they have slighted.

THE LIGHTING OF THEATRES.

"*Video meliora proboque, deteriora sequa*" might well be the confession of the public, and if that be any consolation, not of the British public alone. We go on using imperfect and dangerous appliances long after "a more excellent way" has been discovered and found practically adequate. From time to time comes a sharp lesson in the shape of some grave calamity, and then the sage public denounces men of science for not devising a remedy! Alas, the remedy exists, but the sage public will not adopt it.

In nothing does this discreditable trait of human nature come more glaringly under our notice than as regards the lighting of public buildings. We still cling to gas and petroleum, despite such catastrophes as that of the Cathedral of Santiago and the recent havoc in the Opéra-Comique at Paris. For a leisurely man it might be an interesting pastime to ponder how many more human beings must be roasted to death and how much more valuable property destroyed before the electric light is introduced as the sole illuminant in theatres and in all places where similar conditions exist?

We do not wish to be misinterpreted: where there are no inflammable or explosive materials placed near the burners, and where, in case of need, there is a ready exit for the persons present, both gas and petroleum do excellent service. But in a theatre, all the conditions for a destructive conflagration seem to be brought together with a wonderfully perverse ingenuity. There are we might almost say acres of painted canvas; there is a vast quantity of dry, light woodwork beneath, behind, and above the stage. There are hangings and curtains all eminently inflammable. And amidst these combustibles—say at a pantomime—gas-lights flare at distances of a few inches. An unexpected current of air, the carelessness or awkwardness of a stage carpenter or a scene-shifter or the casual failure of some mechanical appliance may bring one of the flames into actual contact with some inflammable material, and the result is almost instantaneous.

The architectural shortcomings of theatres, the invariable lack of means for a safe and rapid exit, glaring as they are, do not come within our cognisance. But we must remind the reader that theatres are far from being the only places where the use of gas is eminently dangerous. Let the reader, if he have occasion to pass in the evening any of those over-grown drapery emporiums which have sprung up in all parts of London, note how often thin tissues are hanging in the windows so as to all but touch the surrounding gas jets. He cannot help wondering that accidents are not more frequent. That fires do occur in such localities is well-known, but that they are often escaped by a hair's breadth is not considered. Cases of this kind have repeatedly come under our notice, though they have, perhaps, by special arrangement, received no mention in the Press.

Curiously enough, it appears that the deplorable accident at the Opéra Comique had been foreseen as at least probable. About a fortnight previously the Minister of Public Instruction, in answer to a question put by a member of the Chamber concerning the risk to which the staff of this theatre were exposed, distinctly said that the Opéra Comique was menaced at no distant date by a conflagration, and that the consequences would be disastrous. Such a prediction, so definitely put forth and so promptly fulfilled, would make the fortune of Old Moore.

What is, perhaps, still more curious, is that the ad-

ministration of the Opéra Comique were already "thinking about" the introduction of the electric light and the suppression of gas, and that, as we learn, the Edison Company had already received the order for the installation. Had this catastrophe been delayed only for a few days it would, therefore, never have happened at all. This may be said with confidence, since in the present case the accident has been distinctly brought home to a row of gas-jets placed along a frieze.

Public opinion in Paris very naturally denounces the tardiness of the directors of theatres in making the necessary change. It seems that only six of the Paris theatres have adopted the electric light, and that even in these six gas is not yet entirely suppressed.

The legal interdiction of gas at all places of amusement is, therefore, now formally demanded. The proprietors are reminded that if the electric light is under certain circumstances more costly than gas, its introduction is attended with compensation in the shape of a reduction of the insurance premium.

It must not be forgotten that wherever gas is used, the burners have to be lighted when requisite. For this purpose matches have to be struck, and are then very often thrown down still alight and may readily fall upon some inflammable matter. Or else tapers are employed, fixed to the end of poles. Here the slightest unsteadiness in the hand of the operator may kindle not the gas, or not the gas only, but some other object. We have, indeed, quite recently noticed a very ingenious system for igniting gas jets by electricity. But it seems to us simpler to instal the electric light at once rather than put up gas fittings, and then to superadd the above-mentioned device for lighting the burners.

In all extensive premises where any possibility of a conflagration exists, not merely in theatres, but in textile manufactories, warehouses, drapery establishments, powder magazines, and in all places where ardent spirits, essential oils, petroleum, ethers, &c., are stored, electro-thermostats should be fitted up as automatic watchmen, to indicate any abnormal rise of temperature.

Whether our legislature will prohibit the use of gas in theatres within any reasonable time is, of course, a question upon which we cannot offer an opinion. But as to the justice, or rather the necessity of the step, there is little room for doubt. Any night, especially in the pantomime season, may witness in London such a catastrophe as that which has just changed the Opéra Comique into a veritable Opéra Tragique.

NOTES.

Electric Lighting in Bakeries.—The Gülcher Electric Light and Power Company has just completed the lighting of the new factory built by the Civil Service Bread Company, in Horseferry Road. The electric light has been adopted throughout the whole of the premises, and the installation consists of a No. 2 Admiralty type Gülcher dynamo machine fitted with a heavy turned flywheel which is driven through counter-shafting from the 14 H.P. Otto gas engine used for operating the main line shafting. The dynamo is placed in a very neat dynamo room made of pitch pine and varnished; the sides and ends are glazed so that ample light is admitted. The current is first led to a main switch-board which carries 12 sub-circuit switches, and then through 12 adjustable resistance coils. Each circuit is fitted with a fusible cut-out. There are employed 8 2,000-C.P. Gülcher arc lamps and 21 16-C.P. incandescents, and each arc lamp is fitted with the company's patent rope gripper, which prevents the lamps accidentally slipping, and also avoids the necessity of in any way coiling up or fastening the lowering cord. The incandescent lamps are suspended by silk flexible cords, fitted with ceiling roses and cut-outs and 10-inch opal reflectors.

Electric Lighting and Music.—The new concert hall in the Liege Conservatoire de Musique is lighted throughout with arc lamps to the complete exclusion of incandescence lights. The principal hall is illuminated by 10 lamps arranged in a circle round the cupola; the stage is lighted by six lamps, the lobby with three, the staircase four, the entrance hall three, and the portico by one. The colours employed in the interior decorations have been carefully selected with regard to the light so as to avoid any strain to the eyesight. The current is supplied from two dynamos, each worked by a 20 H.P. Otto gas engine. The lamps and dynamos are of special construction, designed by M. Pieper, the contractor for the entire installation.

Inner Temple Lighting.—We hear that the battery power in this installation has lately been increased. The cells formerly employed were of the "E. P. S." type, but the new battery is composed of 55 of the improved cells made for Drake & Gorham by Messrs. Elwell-Parker, Limited.

Nothing Like Competition.—It is reported in Charleston, S.C., that the local gas company contemplates erecting an electric light plant, and that the electric light company is about to build gas works.

The Thomson-Houston Lighting System.—We have frequently called attention to the marvellous advances made by this system, and we now learn that it is in use by close upon two hundred local companies, including gas companies, in America. The system was practically unknown before 1883.

Electric Lighting in Japan.—In Japan, the Chicago *Herald* states, most of the principal cities are now lighted by electricity, and many of the finest houses are illuminated in the same way. A large Edison plant has recently been ordered for the palace of the Mikado at Tokio, a very large building, or rather a cluster of buildings connected by corridors and covering several acres. The Chinese do not take hold of improvements as readily as the Japanese, but are beginning to see their advantages. The Coreans are ready to adopt all modern ideas, particularly if they come from the United States. The palace of the King of Corea has a plant of 300 (Edison) lights, and was first illuminated on the birthday of the King's mother-in-law, on the 20th of February, with great ceremony. As no foreigner is allowed to look upon the features of the King or Queen, the workmen took great risks when they were putting in the apparatus, for if they had, even by accident, seen the face of the King they would have been put to death, according to the custom of the country. They were carried into the palace and through the corridors in palanquins, and trumpeters were sent ahead of them so that the royal family might keep out of their way.

Electric Lighting in the Royal Navy.—The Indian troopship *Malabar*, which returned to Portsmouth last week after having been re-engined and thoroughly repaired at Hull, is now lighted in every part with the electric light, which is supplied by two independent sets of engines and dynamos located above the engine room. Mr. R. Woodley, of London, under an arrangement with Earle's Company, has carried out this work, and also supplied the saloons with electric bells.

Proposed Electric Lighting at Penzance. — The Borough Surveyor of Penzance has been directed to continue his inquiries with reference to the cost of introducing the electric light, for public purposes, into that town. The present lighting of the borough affords anything but general satisfaction, and the report which is shortly to be presented by a committee appointed to enter into the matter will be anticipated with extraordinary interest. A strong opinion appears to prevail among the inhabitants of Penzance that the authorities should follow the example afforded them by Taunton and give the electric light a fair and unbiassed trial.

Electric Light an Antidote to Panic.—Mr. Horace Sedger, of the Prince of Wales's Theatre, writes to the *Standard* with reference to the recent disaster in Paris as follows :—"In reading your reports of the terrible calamity which recently occurred at the Opéra Comique, in Paris, in aid of the sufferers from which I have arranged to give my theatre for a *matinée* on Wednesday, June 8th, I think it must be allowed that the panic was caused, or, at any rate, greatly aggravated, by the fact of the theatre being in total darkness, owing to the gas having either gone out, or having been turned out; whereas, had the electric light been in use, as it is here at the Prince of Wales's and other London theatres, no such terrible result could have happened. In support of this, it may interest some of your readers when I tell you that only a few weeks ago, during the performance here of the evening farce, one of the gas bags used in connection with the lime light (which since the evening in question I have entirely dispensed with in the theatre) exploded, the concussion being sufficiently great to put out the gas in the auditorium. All confusion, anxiety, or panic was, however, averted owing to the electric light being in use throughout the theatre; for simultaneously with the explosion, the lights not used during the performance were switched on before the audience could realise what had occurred. I went to the footlights, explained what had happened, and ordered the iron curtain to be lowered. Everyone remained seated, and the performance was continued after some 10 or 15 minutes' delay."

Electric Lighting of American Coal Mines.—The mines in the Oregon coal districts are being lighted up by electricity at the instance of the Oregon Improvement Committee. Electric roads at the mines for hauling coal are also proposed.

Ship Lighting.—On May 19th there was launched from the shipbuilding yard of Messrs. Hanna, Donald and Wilson, a steam yacht of 33 tons named the *Hirondelle*. The yacht, which is of schooner rig and sails, is supplied with triple expansion engines of 25 H.P. Her dimensions are length over all, 73 feet 6 inches; breadth 10 feet 9 inches; depth, 6 feet 6 inches. There is also fitted a combined engine and fan for causing forced combustion. This is of great importance in hot climates to keep the stockhold cool, and to force combustion of bad coal. This engine also serves to drive a circulating pump for surface condenser, also dynamo for lighting ladies' cabin, saloon, smoking house, engine house, and after cabin. The electric lighting of this yacht was entrusted to Messrs. Robertson & Co., electrical engineers, Paisley, under the personal supervision of Mr. George Robertson, jun., and has been entirely successful. This is the third vessel fitted by the firm for the same builders.

The trial trip of the *Tantallon Castle* took place on Saturday last, when the thorough sea-going qualities of the vessel were demonstrated. She has been fitted throughout with the electric light by Mr. Rankin Kennedy. A Kennedy new type ironclad dynamo, running at a speed of 650 revolutions per minute, supplies current for 35 20-C.P. Swan lamps. The fittings are silver plated, and the lamps are enclosed in neat cut-glass globes. The installation has been carried out under the superintendence of Mr. James Campbell, for Mr. Kennedy's firm. This is the third vessel fitted up by Mr. Kennedy for the company which owns the *Tantallon Castle*.

Electric Lighting of Dundalk.—The first trial of Mr. M'Carthy's plucky undertaking at Dundalk was made last Friday night, and was apparently very successful. The local papers speak in enthusiastic terms of the transformation which occurred at 9 o'clock, when the 24 arcs were simultaneously lighted up. The Town Commissioners are so well pleased with the electric lighting that they have decided to discard the remaining oil-lamps, and add several more arcs to those already installed.

Gas Engines for Electric Lighting.—The Brussels *Moniteur* of the 1888 exhibition says :—"The question of the use of gas motors for electric lighting is frequently discussed; the advantages of this application are well-known. In the use of motors with one cylinder, applied to electric lighting, it is difficult to obtain steadiness in the lamps if there be no accumulators employed. It is obtained if very thick filaments be used, as in the Gérard lamps. There is then a sort of flywheel action, the filament itself keeping up the heat. The essential elements of success are: the motor must take in gas continuously, that is to say, the regulator must be useless. If the power absorbed by the dynamo be less than that furnished by the motor, the gas must be turned off at the stopcock until the regulator sinks. If then the speed be too small, resistance must be introduced into the circuit; and, by combining in a suitable way these two variables, the resistance in the circuit and the access of gas, a very good result will rapidly be arrived at. If accumulators be employed, the gas should be regulated until the dynamo produces a current only 2 or 3 volts above that of the accumulators, and then the resistance should be adjusted until the intensity becomes that which is most suitable for the kind of accumulators employed."

Electric Lighting of the Hotel Victoria.—The neighbourhood of Charing Cross and Trafalgar Square is fast becoming a vast aggregation of gigantic hotels. The most recent of these palatial buildings is the Hotel Victoria, opened on Wednesday. The electric lighting of the hotel has been carried out by Messrs. Thompson, Ritchie & Co., of Winchester House, E.C. The plant comprises two pairs of vertical engines by Messrs. Browett & Lindley, each engine driving an Elwell-Parker dynamo, capable of doing the whole of the lighting required, so that a complete duplication is secured. There is also a set of E.P.S. accumulators for the lighting after midnight. The number of lamps exceeds 1,000. The electroliers, brackets, lampholders, &c., were supplied by the Walsall Electrical Company.

The Electric Light at Poole.—A new Free Library is being erected at Poole, and with the object of hastening its completion the aid of the electric light has been called in, so that the work may be pursued throughout the night, relays of men being employed. Messrs. Mortimer & Shepherd, who are carrying out the electric lighting experiments at Bournemouth, erected an arc lamp over the new building, and this has been an object of great interest to the townspeople.

West African Land Line.—The Eastern Telegraph Company intimates that a land line has been constructed and is now open for traffic from Accra, on the West Coast of Africa, to Winnebah, Salt Pond and Cape Coast Castle.

The Upward Battery.—Messrs. Woodhouse and Rawson have just completed an installation of this system for lighting the private residence of Mr. E. Harlock, at Ely, Cambridgeshire. The plant consists of four Upward cells, with eight columns for holding the chlorine gas, the electricity being stored in E.P.S. accumulators. The battery is fixed in the brewery adjoining the house near the mash tun, and immediately below the fermenting tuns, a convenient position, which could not have been made available but for the entire freedom from smell or noxious fumes from the battery.

Elieson's Tramway System.—The projected starting of the Elieson electric locomotives on the Stratford-Manor Park line, on Wednesday last, did not take place, owing to the overlooking of a little technical matter. At the last moment it was found that the license necessary for the drivers had not been obtained from Scotland Yard. But on Monday, says Mr. Elieson, a start will be made in any case.

The Spezia Electric Lighthouse.—"C. P. S." writing from the Grand Hotel, Viareggio, on May 28th, sends the following to the *Standard* :—"In the course of an interesting discussion at the Institution of Civil Engineers in December last, on the Electric Lighthouse of Tino (an islet at the mouth of Spezia Bay, opposite the beautiful promontory of Porto Venere), it was stated, as an instance of the extraordinary visibility of that light at long distances, that during the official trials in April last year the rays of its flashes (a group of three flashes every half-minute) illuminated the clock on the Tower of Volterra, no less than 75 miles distant and at an altitude of over 2,000 feet above sea-level, casting a distinct shadow on the disc. Be it noted that the Tino light, of five to six million candle-power, is one of the most powerful in the world, and was put up early last year under the direction of Cav. L. Luiggi and the late Comm. Parodi, of Geneva, on behalf of the Italian Government, the optical apparatus and machinery having been supplied by Messrs. Chance Brothers & Co., of Birmingham, according to the designs of Dr. John Hopkinson, M.I.C.E., F.R.S. I have lately had frequent occasion to observe the wonderful illuminating and penetrating power of that light from various points of the Tyrrhenean littoral, and in all weathers. Thus, from a point three thousand feet above sea level, in the Carrara Mountain range, from which, on a clear night, even the oil lights of Viareggio, Leghorn, and of the islands of Capraja and Gorgona are visible, the flashes of the Tino light shooting across the sea may be seen illuminating the whole coast of the marble district and the lower slopes of the mountains with almost magic effect. Seen from the pier of Viareggio, 30 miles distant, the brilliancy of the light is positively dazzling, and the shadow it casts of the Viareggio Lighthouse, or of persons walking on the pier, is distinctly observable. Nay, even in the intervals between the triple flashes, the light is clearly visible to the naked eye in the shape of a red spot just about the size and brilliancy of the old Tino oil luminary. Again, though dimmed by heavy rain and thick fog, as it has been during the last few nights, the triple flash is always clear and unmistakeable, and then produces, through the quasi-opaque atmosphere, and at a distance of 30 miles, the effect of the blurred disc of the moon on a small scale. This remarkable penetration power of the Tino light is conclusive proof, not only of how admirably it is designed and suited to its essential purpose as a guiding light under the peculiar atmospheric conditions of the Mediterranean, but also how hazardous it would be to dip—viz., to divert such a light, as has been suggested by some—from the horizon to the nearer sea in foggy weather, forsooth, according to the *bene placito* of the man in charge, on the presumption that in such weather the luminous rays could not reach the horizon and would therefore be wasted. This presumption is wholly fallacious in the Mediterranean ; for in the Bay of Spezia, owing to its proximity to the Appennines, the rainfall is much greater than in other parts of the Tyrrhenean Sea, and banks of land fog can often be seen hanging over the bay and Tino, when the horizon as far as Leghorn, Gorgona, and even Corsica is perfectly clear."

Making Death Painless.—Speaking of the Bill passed by the Pennsylvania Legislature, requiring that all judicial executions for capital crimes in that State shall be accomplished by means of electricity, the New York *Electrical Review* says :—"The most characteristic feature of the social philosophy of the age is its excessive sentimentality. Society appears to be more anxious to abridge the miseries and sweeten the punishment of such criminals as happen to fall under the sword of justice than it is to punish crime. If criminals were swiftly and sternly brought to justice there would be fewer to punish. The idea that punishment is to be made as mild as possible tends to encourage crime. Electricity, if it can be made available to produce instant and painless death, will be a favourite agent for self-murder."

Stealing Gutta-Percha.—Robert Callan, 33, basket maker, and Charles Lloyd, 20, stroker, were indicted for stealing a quantity of gutta-percha, value £25, the goods of the Telegraph Construction and Maintenance Company, Limited, Callan's employers. They were further charged with receiving the same, well knowing it to have been stolen.—On the night of Friday, April 29th, Detective-serjeant Robinson and Detective Mather saw the prisoners in Hyde Road, Hoxton. They were carrying a sack which evidently contained something heavy. The constables, after having watched them for some time, stopped them and informed them that they would take them into custody for being in possession of stolen property. Callan made a desperate resistance, but Mather called the assistance of a uniform constable, and they were secured. It was subsequently ascertained that gutta-percha had been stolen from the works of the prosecutors, in whose services Callan had been for six years as a labourer.—The prisoners were both convicted, and previous convictions were proved against them, including seven years' penal servitude against Callan.—Mr. Edlin sentenced Callan to one year and seven months' imprisonment with hard labour and Lloyd to 15 months' imprisonment with hard labour.

Obituary.—The Paris Academy of Sciences has of late sustained some heavy losses. The recent deaths of Jamin and of Boussingault have been followed very unexpectedly by that of the perpetual secretary, the eminent physiologist, Vulpian. The deceased who was born in 1825, became in 1864 professor of general physiology at the Museum of Natural History, was appointed in 1872 to the chair of experimental pathology in connection with the Academy of Medicine, and last year he was elected secretary of the Academy of Sciences. His researches, though numerous and of the highest scientific value, relate to the phenomena of animal life and do not, in consequence, come within the range of our notice. In his studies on the functions of the nervous system he was led to investigate the conditions under which electric shocks may become dangerous or fatal to man—a question of great importance to the practical electrician. Vulpian was interred on the 21st of last month, the official discourses being pronounced by Mr. Janssen, M. Charcot, and M. Brown-Séquard.

How to Become an Electrical Engineer.—At a recent meeting of the Polytechnic Society of Berlin, the question was asked : What studies are best to fit one to be an electrical engineer? Herr Frishcen, one of Siemens and Halske's experts, replied that much practical experience was required. After graduating from school, a rigid course in an advanced technical school should be taken, followed by an apprenticeship in a factory. He remarked that at present the title of electrician is used too freely, and that the claim of some to it is that they have nailed up a few wires.

Personal.—Mr. A. A. Campbell Swinton has given up his engagement as electrical engineer to Messrs. Sir W. G. Armstrong, Mitchell and Co., Newcastle-on-Tyne, and has removed to London, in order to undertake the management of the Equitable Telephone Association, Limited, 75, Queen Victoria Street, E.C.

Taxing Telephones.—An important decision has been delivered by the tribunals of New Orleans. The Town authorities have attempted to levy a tax of 5 dollars on every post erected by the telephone company. This tax has been declared illegal.

The Battery of Dr. Conrad Pabst.—The positive plates of this battery are blocks of iron ; the negative, carbons, with which is incorporated oxide of zinc. Each cell gives from 1 to 1·2 volt and has a resistance of from 8·8 to 1·2 ohm with slight variation while supplying current. The iron poles last from two to 10 years, and by the absorption of oxygen from the atmosphere the depolarising qualities of the negative plate are continually renewed.

Alleged Gas Swindles in New York.—The *New York Herald* is working up an agitation against certain alleged malpractices on the part of the gas companies. We may quote one or two of the instances given. A reporter called on the proprietor of one of the largest hotels on Broadway, who consented to compare his bills. Here is the extraordinary result :—

	Dols.
March, 1886, when gas was 1 dol. 75 cents a thousand cubic feet—243,000 cubic feet	364 50
March, 1887, when gas was 1 dol. 25 cents a thousand cubic feet—349,300 cubic feet	436 75

The proprietor of this hotel said that no more light was used in the last month than in the first. A gas engineer was asked to explain how it was that, although no more gas was burned in one month than in the other, the consumer had to pay 72 dols. 25 cents more for gas at 1 dol. 25 cents than he did a year before, when the price was 1 dol. 75 cents. "It is easy to explain that," he said. "The Consolidated Gas Company forced 106,300 cubic feet of gas more than usual through the meter by simple pressure. Of course there was no more light given, in fact, not as much, but the meter registered it, and that is why the bill was higher at a lower price. You will notice that the increase in cubic feet produced by pressure amounts to over three-sevenths of the whole original bill. This is a case of downright robbery. If I was the owner of that hotel, I would bring a suit to recover the amount taken from me by the fraud." In another case discovered by the reporter, in a large dry goods store on Eighth Avenue, although the owner did not get any more light, the Consolidated Gas Company is said to have forced in two months 84,900 extra feet of gas through the meter, and he had to pay, for what did him no good whatever, 106 dols. 25 cents. During two other months electric lights were used in this establishment on Saturday nights. The owner expected that his gas bill would not be half as large as in the preceding months. But when the bill came in there was so little difference that he pronounced it a gross attempt to cheat.

Melbourne Centennial Exhibition.—A circular is being extensively circulated inviting exhibitors to the International Exhibition which will be held at Melbourne next year in celebration of the centenary of Australia. The offices of the commission in England will be at 8, Victoria Chambers, Westminster, adjoining the offices of the Agent-General for the Colony, and all communications should be addressed to the Secretary at that address. No charge will be made for space. The detailed prospectus and forms of application can be obtained on personal or written inquiry. Applications for space should be returned to the London offices on or before August 31st; but it is requested that, in view of the distance at which the exhibition is held, and the time necessarily involved in correspondence respecting the arrangements for the perfect accommodation of all exhibitors, the applications may be sent in at as early a date as possible.

Taussig's Fire and Burglar Alarm.—In order to introduce this system of fire and burglar alarm combined with a telephone line, to the business people of Manchester, Dr. Julius Maier has been permitted to connect the offices of the Lancashire and York Bank in the Royal Jubilee Exhibition Building with the exchange of the Lancashire and Cheshire Telephonic Company. The box containing the automatic sending apparatus is fixed in the bank, and the Morse receiver with bell attached in the switch room of the exchange. In the present transmitter the clockwork is wound by a small electro-motor. It is probable that it will be extended to other parts of the building.

Miners' Lamps.—The terrible colliery explosion last week has induced Mr. Ellis Lever, of Manchester, to renew his offer of £500 for the production of a perfect portable electric miners' lamp within the Jubilee year.

The Electrical Unit of Energy.—Mr. John T. Sprague in the columns of the *Electrician* defines the above as the *volt-ohm-ampère-second*, a combination singular for the repetition involved in it. The volt-ampère or watt we understand, and the volt-ampère second, watt-second or joule we also know, but the combination referred to by Mr. Sprague passes our comprehension. The writer would scarcely talk of a 12-inch foot-rule, though the definition given above is not less absurd.

Electric Motors and Elevators.—In an article on "The Relative Economy of Elevators," *Engineering* says :—"It is not to the credit of the engineering skill of those engaged in the exploitation of electric motors that in many instances their application to elevators is made by using the motor to drive a pump which forces water into either an elevated or a closed tank, increasing the number of conversions of energy and the losses attendant thereto in an unnecessary measure. They should rather apply the skill to the production of electro-motors which would operate with the needful smoothness, and also be subject to the small range of motions and ready control by the operator as is requisite in all elevators."

Technical Education in America.—Judging from the following sensible observations in the *Electrical Review* of New York, the technical colleges of America do not finish off the students so perfectly as similar institutions in England are supposed to do. "A few weeks more, and a new army of young electrical engineers enter the field of practical life. They know formulæ and theories by the page, and can design machinery of many descriptions, sometimes making a mistake not uncommon among old engineers—that of trying to put two pieces of metal in the same place. The less the real knowledge, the more one is apt to think of one's attainments. So much must be accomplished in a technical course of three or four years that a part is done hurriedly. A practical steam engineer of high reputation once remarked that he had rather face a man with a shot gun, bulldog included, than a recent graduate with a steam indicator. This feeling—and it is a general one—is not due to jealousy, but to a deficiency and corresponding self-assertion in practical matters, on the part of the beginner. This year's graduates ought not to expect leading positions at once. They can learn more in humble places, and their mistakes are far less likely to disturb others or injure their own reputation. In electrical engineering more than in any other profession, one is now called upon to design new machinery and apparatus. There is always a cheap and simple design, and many expensive and impracticable ones. Practical experience in the workshop only will fit one to select out of the many the most suitable and cheapest method of manufacture. Just as a dynamo builder must know something of current and electro-motive force required for the lamps or motors, so a manufacturer needs a knowledge of all that pertains to electricity, if his machines and other products are to be commercially successful."

Society of Telegraph Engineers and Electricians.—The second meeting of the students was held in the society's library on Thursday evening, the 19th ult., Prof. Perry, D.Sc., F.R.S., in the chair. The chairman, after making a few remarks, called upon Mr. A. H. Bate to open the discussion upon Mr. Fitz-Gerald's recent paper "On Reversible Lead Batteries and their use for Electric Lighting." Subsequent speakers were Messrs. Cooper, Paul, Tidd, Hayne, Hume, E. W. Smith, Rance and Handcock; several of whom mentioned and described battery plates of their own design. Mr. Tidd showed some plates in bad condition, owing to amalgamation due to mercury contacts. Prof. Perry closed the discussion, giving a short sketch of the great difficulties experienced by those who introduced secondary batteries, making special reference to Prof. Ayrton's and his own work with the Faure accumulator. A vote of thanks to the chairman terminated a well sustained discussion.

An Electrical Experiment.—Mr. C. Voorhis, of the National Suspender Company of New York, in handling some of the rubber threads used in the manufacture of suspenders and other elastic webs, noticed that the threads at times repelled each other. The repulsion was naturally attributed to electrification. The elastic rubber strips used in the experiment (which were 17 feet long and about one-sixteenth inch square) were suspended from the ceiling in one of the apartments of the *Scientific American* office, and were electrified by simply brushing them with a feather duster. The threads became more and more divergent as the electrification proceeded, until it finally became impossible to approach the threads without becoming enveloped in them. Upon gathering all of the free ends of the threads together, the repulsion of the threads at their mid length caused them to separate widely. When once electrified, in a dry day the threads retain the charge for hours. They can be discharged by connecting them with the ground through the body, by drawing them through the hand. This curious experiment is one which anybody may easily try at small expense. It illustrates the phenomenon of electrical repulsion in the most striking manner.

Railway Station Lighting by Electricity.—The central railway station in Buda-Pesth is lighted by 70 arc lamps of 600 C.P., 430 glow lamps of 20 C.P., and 461 glow lamps of 10 C.P. The engineer in charge, Herr Kovacs, has just handed to the Board of Directors a report on the working expenses of this installation. The whole of the arc lights are nightly in use; but of the incandescent lamps 279 are not in regular use, these being fitted in state rooms, board rooms, &c., and only lighted on special occasions. The total annual 10-candle lamp-hours were 2,770,775, in which figure are included the 20-candle lamps, as equivalent each to two 10-candle lamps. The total annual arc lamp-hours were 211,390. The annual working expenses are given in Austrian money, of which, for the convenience of our readers, we (*Industries*) give here the approximate equivalents in English money, calculated at the current rate of exchange: glow lamps burned out, £260; carbons for arc lamps, £445; fuel, £470; lubricants, £110; petty material, £180; personal expenses and wages, £725; engine repairs, £98; electrical repairs, £55; total, £2,343. Since the installation is mixed, it is desirable to obtain a common basis on which to estimate the working expenses per unit of light, and for this purpose Herr Kovacs estimates 15·8 10-candle glow lamps to be equivalent in energy to one of the arcs, and on this assumption the total annual 10-candle lamp-hours result as 6,284,030, the expenses being at the rate of ·46 kreuzer (·088 of a penny) per 10-candle lamp-hour. Comparing this with gas at 5s. per thousand, which is about the price charged by the Vienna Gas Company, he finds that the 10-candle gas burner costs per hour 1·2 kreuzer (·23 of a penny), or nearly three times as much as the electric light.

Central Station Concessions.—The Edison Company of Chicago has secured a concession of 25 years for a central incandescence lighting station in that town. It has at last been authorised to open up all the streets for the wires, the authorities having finally decided in favour of underground lines.

Underwriters' Wire.—With reference to the kind of wire known by this distinctive title, to which we have more than once referred in "Notes," a jury of experts in Philadelphia has just "particularly called to notice the unreliability of the so-called 'underwriters'' insulation when used in the open air."

Underground Electric Light Conductors.—The Imperial Continental Gas Association of Vienna has obtained permission to lay underground cables between its central electric lighting station, the Opera House, and the new Burg Theatre. The cables will be of the Berthoud-Borel type.

Glasgow International Exhibition.—The prospectus of this Exhibition, which is to open in May 1888, is now being issued, and contains the names of the officials and of the members of the General Council, the Executive Council, the various Executive Committees, and the sub-Committees. The offices are at 27, St. Vincent Place, Glasgow. The Lighting Committee, of which Sir William Thomson is convener, includes also Principal Jamieson, of the College of Science and Arts, and Mr. John Watson, of Earnock, who was, we think, the first gentleman in Scotland to adopt the electric light for a mansion, and subsequently for collieries. It will be noticed, however, that with true Scottish caution the committee is not, as in the cases of other recent exhibitions, launched as an "Electric" Lighting Committee, so that it may be assumed that the illuminant is yet to be decided upon, and that, for instance, a fair consideration will be given to the claims of the mineral oil so largely produced in the neighbourhood. Electricity forms a distinct class in the arrangement of the exhibition, and is to be dealt with under the following headings:—Generators—dynamos, primary and secondary batteries, thermo-electric batteries. Conductors—submarine cables, and apparatus for laying them; ærial wires and underground cables; insulators and poles; insulating and coating materials; joints and connections; pipes, tubes, troughs; electric light leads. Testing and measuring apparatus—galvanometers; magnetometers; dynamometers; volt meters; current meters. Telegraphic and telephonic apparatus—needle instruments; A B C instruments; Morse instruments; type printers; relays; duplex and quadruplex apparatus; keys; recording instruments; automatic transmitters; electric bells; indicators; telephones and fittings; microphones; lightning protectors. Electric lighting apparatus—lamps; resistance coils; cut-outs; safety catches; switches; fittings for lamps. Distribution or utilisation of power—electric railways; electric motors; boats, tricycles, and other conveyances driven by electricity; systems of distribution; domestic electric lighting applied to apartments. At Glasgow, for the first time, will be afforded facilities for the exhibition of electrically propelled boats, the river Kelvin, which flows through the grounds, being of a sufficient width and depth for this purpose.

Electric Accumulators in Belgium.—The Union Power and Light Company is, *Industries* states, in negotiation with a local syndicate, for working its system of accumulators in Belgium. The basis of the arrangement is stated to be a royalty of 1d. per kilogramme of plates made. On the other hand, the Gadot accumulator is being vigorously pushed by the Société Industrielle, and very conclusive experiments have been made with a battery of 100 cells. The installations at Borgerhout and at Antwerp are to be provided with accumulators of the Somzée type. It is to be feared that the employment will not be free from litigation. There is, on the one hand, M. Julien, who is reported as having determined to oppose generally any accumulator in which oxides of lead are supported by metallic strips; whilst, on the other hand, the representative of the storage cells maintains that the employment of a grid with pasted-in active material is an infringement of Faure-Sellon-Volckmar patents, and some complicated law suits are expected.

The Telegraph Service.—Replying in the House of Commons recently to Sir William Harcourt, the Chancellor of the Exchequer said the telegraph service in 1880–81 showed a surplus revenue of £313,284. In 1886–87, instead of a surplus, it was anticipated that there would be a deficiency of £223,110, so that in the six years there was a falling-off of no less than £536,394. This was omitting the interest on the purchase money of the telegraphs, £326,418 a year. If this were taken into account there would be a deficiency for the year 1886–87 of £549,527. The falling-off in net revenue was not due to diminished receipts, but to increased expenditure.

Electric Lighting in the French Navy.—The ironclad *Le Furieux*, which is now being constructed at Cherbourg, has recently been fitted with two projectors of 15,000 C.P. each, and 150 16-C.P. incandescent lamps. Gramme dynamos, driven by Brotherhood engines, are used. In the Mediterranean, experiments have been made for the protection of harbours against torpedo attack. The search light is placed on a revolving platform, about 33 feet above the level of the sea, and by changing the position of the arc in the lantern, it is possible to either illuminate a considerable area, or to concentrate all the light on one point. During these experiments, according to the Paris correspondent of *Industries*, it was found that the approach of a torpedo can be detected, even at a considerable distance.

A Flat Magnifying Lens.—A lens which magnifies and yet is perfectly flat on both sides is made at Jena by the manufacturer of Prof. Abbe's new optical glass. The lens consists of a single disc whose density varies so that its refractive power decreases regularly from the surface inward.

Gas Monopoly.—The action brought by the Municipality of Antwerp against the Gas Company has been decided in favour of the latter, whose monopoly has been confirmed up to the year 1912.

Underground Cables.—The Western Union Telegraph Company has lately ordered 10 miles of a 19 conductor cable, and 36 miles of a 60 conductor cable, for use in New York. Waring's system has been decided on.

Crookes's Patent Ampère Meter.—One of the most recent developments of the heat indicating paint recently described by us is Crookes's patent ampère meter. The instrument consists essentially of a flat coil of thin wire, painted with heat indicating paint, and a screen round it, coated with ordinary red paint of the same shade. Coils of thick wire are placed in parallel circuit with the thin wire, and their resistances are so adjusted that by setting a commutator, the point at which the indication of an excess of current takes place can be varied to suit different requirements. When an electric current is passed through the instrument the thin wire becomes warm, and when the current exceeds a certain quantity, the temperature is raised sufficiently to change the colour of the paint to black, thus warning the man in charge that an excess of current is passing. On the current being reduced the temperature of the coil falls, and the paint returns to its original red colour.

The School of Electrical Engineering and Submarine Telegraphy.—In addition to the results quoted in our issue of May 20th, the following students who had previously gained the school's certificate in lighting and power transmission, obtained it also in telegraphy and telephony in a recent examination by Mr. H. R. Kempe, the following being the percentages :—Sanders, 100 per cent.; Mott, 96; Levin, 78; and Ryves, 70 per cent.

Underground Telegraph Lines.—Mr. W. H. Preece stated at the last meeting of the Society of Telegraph-Engineers and Electricians, that a scheme would be submitted to Parliament asking for the expenditure of the sum of £2,000,000 for the substitution of underground wires in the place of a large portion of the present aërial lines in this country.

NEW COMPANIES REGISTERED.

New Gülcher Electric Light and Power Company, Limited.—Capital: £70,000 in £1 shares. Objects: To acquire the business, assets, and goodwill of the Gülcher Electric Light and Power Company, Limited. Signatories (with 1 share each): *Daniel de Castro, 6, New Square, Lincoln's Inn; *S. Studd, Bedford House, Upper Norwood; W. C. Mountain, 2, Rothsay Villas, Wandsworth; *W. Wallace, 27a, Old Bond Street; *Major J. W. Minchin Cotton, 28, Ampthill Square, N.W.; *T. Lloyd, 53, New Broad Street; *H. Grewing, 14, Austin Friars. The signatories denoted by an asterisk are the first directors. Qualification: 250 shares. Remuneration: £1,200 per annum, or such larger sum as shall be equal to 10 per cent. of the annual net profits, but not exceeding £2,000 in any year. Registered 25th ult. by Trinders & Co., 47, Cornhill, E.C.

Automatic Electrical Apparatus Company, Limited.—Capital: £16,000 in £1 shares. Objects: To acquire the patent right to be granted for an invention for completing electric currents (No. 10,680, dated 20th August, 1886), for which provisional protection has been granted to Percival Everitt. Signatories (with one share each): G. R. Burn, 6, Bell Yard, Doctor's Commons; H. D. Burn and R. W. Burn, Boylands Oak, Streatham Hill; R. Bedford, South Ealing; A. J. Monshall, 24, Guildford Road, Greenwich; T. W. Vallis, 83, Lupus Street, S.W.; R. Edwards, C.E., Deal. Messrs. Percival Everitt and G. R. Burn are the first directors. Qualification: £100 in shares. The company in general meeting will determine remuneration. Registered 25th ult. by Adams, Burn & Son, 6, Bell Yard, Doctors' Commons, E.C.

Domestic Battery Syndicate, Limited.—Capital: £20,000 in £10 shares. Objects: To acquire letters patent for improvements in galvanic and other batteries for purposes in connection with electric light, heat, and motive power. Signatories: J. W. Vickers, 5, Nicholas Lane, 20 shares; Major W. F. Despard, 40, Hampstead Hill Gardens, 10 shares; J. Kirkwood, 9, Gracechurch Street, 15 shares; B. Depledge, 3, Gracechurch Street, 10 shares; J. C. Merryweather, 63, Long Acre, 10 shares; J. J. Shedlock, C.E., 9, Gracechurch Street. The signatories are to appoint the first directors and act *ad interim*. Qualification: 10 shares or £100 stock. The remuneration of the board will be determined by the company in general meeting. Registered 28th ult. by Greenop and Son, 9, Gracechurch Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Aluminium Syndicate, Limited.—An agreement of 4th ult (filed on the 19th ult.) between E. Kleiner, of Zurich, of the first part, F. I. R. Leaver, of the Conservative Club, of the second part, J. O. Maund, of 294, Regent Street, of the third part, and G. C. Sutton, of 9, Hills Place, Oxford Street, of the fourth part, provides for the purchase by the company of the invention for manufacturing aluminium, referred to in the application for Letters Patent No. 8,531, dated 29th June, 1886, and the patent rights to be applied for in Austria, Hungary, Belgium, France, Germany and Sweden. The consideration for three equal fourth parts in the patent applied for, is £4,000 cash and 1,400 fully paid shares of £10 each. The other fourth part is to be held for Mr. E. Kleiner. If after 13 months' working the syndicate is of opinion that the patents cannot be worked at a sufficiently remunerative profit, the syndicate is to be wound up, and in the event of the capital not being enlarged or a new company formed, the patent is to be transferred to Mr. Kleiner. If it be proved that the patent can be profitably worked, the capital is to be increased to not less than £100,000, of which at least £50,000 is to be working capital, or a new company may be formed with such total capital. In such event Mr. Kleiner will transfer his fourth share in the patents and as consideration will be entitled to fully paid shares equal to one-fourth of the total of such enlarged capital. Mr. Kleiner is to prove to the satisfaction of the syndicate as follows :—(*a*) That by his process, commercially pure aluminium can be extracted from cryolite at an average rate of one pound from ten

pounds of cryolite. (*b*) That not less than three grammes of commercially pure aluminium can be extracted for every horse-power employed per hour, not less than 100 horse-power being employed nor more than 500. (*c*) That the waste of carbon used in electrolysis solely for obtaining the said aluminium does not exceed in value one farthing for every horse-power employed per hour. Registered office, Rochester Buildings, 138, Leadenhall Street.

CITY NOTES.

Consolidated Telephone Construction and Maintenance Company, Limited.—The sixth annual general meeting of this company was held at the Cannon Street Hotel on Thursday, under the presidency of Mr. C. L. W. Fitzgerald. The directors' report, which appeared in the REVIEW last week, and the accounts were received and adopted, and a resolution was carried authorising the declaration of a final dividend of 2½ per cent., making with the interim dividend previously paid 5 per cent. for the year ended March 31st, 1887. We shall give a detailed report of the proceedings in our next issue.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 27th were £3,248, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for May amounted to £36,495, and to £41,037 for May, 1886.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending May 27th amounted to £4,004.

The Eastern Telegraph Company, Limited. The receipts for May amounted to £48,037, and to £50,741 in the corresponding period of 1886.

NEW PATENTS—1887.

7458. "Curb keys for telegraph cables." J. GOTT. Dated May 25.

7527. "Dynamo-electric machines." R. M. HUNTER. Dated May 25. (*Complete.*)

7530. "Electrical transformers." J. G. STATTER. Dated May 25.

7553. "Regulating electro-motive force of dynamo-electric machines." F. GEORGE. Dated May 25.

7577. "Electric railway cars." N. H. EDGERTON. Dated May 25. (*Complete.*)

7607. "Electro-magnets." H. P. F. JENSEN. Dated May 25.

7611. "Submarine cable grapnels; grapnel rope couplings and connections." W. C. JOHNSON, S. G. PHILLIPS. Dated May 25.

7618. "Electric transformers, induction coils, or inductional resistance coils." W. M. MORDEY, C. E. WEBBER. Dated May 25.

7664. "Primary batteries." L. N. LOEB. Dated May 26.

7683. "Electric alarm apparatus." E. RETTELHEIM. Dated May 26.

7707. "Dynamo generators." W. W. DUNN. Dated May 27.

7720 "Telephone switch." S. S. BROMHEAD. (Communicated by C. A. Hitchcock.) Dated May 27. (*Complete.*)

7745. "Dynamo-electric machines." R. M. BAILY. Dated May 27.

7751. "Electro motors." F. BAILEY. Dated May 27.

7802. "Ammeters and voltmeters." W. E. AYRTON, J. PERRY. Dated May 28.

7818. "Commutators for electric generators." C. COOPER. Dated May 28. (*Complete.*)

7823. "Supplying an electric current to a movable vehicle or machine." R. LAWRENCE. Dated May 28.

7829. "Automatic transmission of steno-telegraphic signals." W. H. BECK. (Communicated by G. A. Cassagnes.) Dated May 28.

7831. "Spun rims for reflectors for electric light." J. TAYLOR, F. RUSSELL. Dated May 28. (*Complete.*)

7834. "Controlling, transforming, regulating, synchronising, and registering electric currents." H. EDMUNDS. Dated May 28.

7857. "Registering meters for electric currents." H. TUDOR. Dated May 31.

7865. "Dynamo-electric and electro-dynamic machines. F. GEORGE. Dated May 31.

7876. "Switch for electric lighting." J. H. HAWKSWORTH. Dated May 31.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

5063. "Improvements in telegraphing apparatus used in connection with engines." W. CHADBURN. Dated April 12. 8d. Consists in providing what is commonly known as the wiper shaft, viz., that shaft by which the valve levers are worked and upon which the starting levers are mounted, or the usual equivalent to such wiper shaft with a disc or lever, or levers, or their mechanical equivalent. The inventor connects this disc or lever, or levers, or their mechanical equivalent by means of a chain, cord or band, or by chains, cords, or bands, or by rods, or by combined chains or cords, or bands and rods with a tell-tale pointer on the telegraph transmitting instrument in such a manner that the position of the wiper shaft or its equivalent is recorded automatically by the engine and without the intervention of the engineer by the tell-tale pointer on the dial of the transmitting instrument, thus if the engine is going ahead, such is indicated from the engine by the position of the wiper shaft and through the connections by the tell-tale pointer on the dial of the transmitting instrument; in like manner, if the engine is going astern, the direction is recorded by the tell-tale pointer. There is one claim.

5091. "Improvements in electrical governors for preventing the racing of marine engines." A. M. CLARK. (Communicated from abroad by E. A. Wahlström, of Frankfort-on-the-Main.) Dated April 12. 8d. Claims:—1st. The employment for the purpose of electrically governing and preventing racing of ships' engines, of electrodes (immersed in the sea and rising out therefrom at the same time as the propeller) in circuit with a battery or other source of electricity, and a solenoid or electro-magnet acting on a valve controlling the supply of steam to the engines, all combined for operation, substantially as specified with reference to the drawings. 2nd. In an electrical governor for preventing of racing of ships' engines, as herein described, the step-like arrangement of the immersed electrodes, whereby a consecutively increasing number of circuits are made as the ship floats deeper in the water, so that the strength of the entire current available for the governing mechanism varies according to the depth of immersion, as specified. 3rd. The combination with an electrical circuit and apparatus, as described, of a float or blade actuating a commutator, and acted on by the displacement or resistance of the water, as described, for making, breaking, or switching the electric current in the manner specified.

5242. "Electric arc lamp." J. L. BALDI and F. TOLLEY. Dated April 15. 8d. Claims:—1. The combination of a rack and pinion and solenoid with movable core and steel rod with core at one end and rack at the other, as described, to regulate the arc. 2. The combination of the iron or steel ring attached to the pinion and the electro-magnet with movable core and the bell crank arrangement to act as a brake. 3. The combination of a rack and section acted on by a solenoid for regulating the arc.

5479. "A method of gauging electric currents and apparatus for that purpose." S. C. C. CURRIE. Dated April 20. 8d. Claims:—1. The construction and use of an electric gauge wherein a stationary and a movable piece of iron are arranged within a coil, so that they both become similarly magnetised when an electrical current passes through the coil, and the movable piece being thus repelled in opposition to a spring or other adjustable resistance, serves by its movement to gauge the current, substantially as described. 2. In an electric gauge constructed and arranged substantially as described, the combination of the coiled bobbin, the piece of iron fixed at one side, and the piece mounted on an index axis which is eccentric to the bobbin, and is acted on by an adjustable spring.

6206. "An electric alarm or check for use in connection with railway signals." J. RICE. Dated May 7. 8d. Consists in the use in connection with outside and electric railway signals of an electric bell or alarm for the purpose of affording an audible means of reminding a signalman that the section of line in advance of him is "blocked," should he, through negligence or inadvertence, operate the catch rod of his starting signal lever with a view to despatching a train on the "blocked" section. The circuit in which the electric alarm is situated has, for a double line of rails, two breaks, one of the breaks being at the indicator controlled, as usual, from the signal station in advance, and the other at the catch rod of the starting signal lever. The claims are two in number.

6287. "Improvements in electric secondary or storage batteries." W. TAYLOR. Dated May 10. 8d. Consists in making a number of lengths of metal proportional to the size of the electrode required. The required number of the said conductors are placed at proper distances apart and one or both ends of each conductor is then connected to a leading bar or principal conductor. The whole is then laid in a suitable mould and a thick paste of a salts of lead cast in it. When hard it is removed from the mould and a light frame of ebonite or other suitable material fixed round it, forming when thus constructed a flat slab of salts of lead with conductors cast in the same at suitable places. It is then formed (electrically) by the usual method. Claims:—1. The formation of electrodes for electric secondary or storage batteries, substantially as illustrated and described. 2. The use in combination with the improved electrode of the mode of connecting said electrode to its suitable main, substantially as illustrated and described.

8475. "Improvements in electric fire alarums." M. A. ISRAEL and H. A. ISRAEL. Dated June 28. 8d. The object of the invention is to give alarm at any fire station (or all if needed) of the first stage of a fire at any house, and also at the same time to give alarm to the house itself. The inventors effect this by laying down wires in each street, connected with an electric bell and battery at any station, the bell bearing the name of the street, whence the wires proceed; and offshoot wires from these into each house in the street by carrying from top to bottom of each house, in the street, wires connected with a bell and battery in the house, and by so arranging further wires in relation to those named, and to an electric push in each room in each house, that a fire breaking out in any room will bring about such action on the push there as to complete the electric circuits to the bell in the house and the bell at the station. There is one claim.

11844. "Improvements in apparatus or devices for the treatment of the eyes by electricity for curative purposes." C. B. HARNESS. Dated September 17. 8d. Consists essentially of a tube or casing containing a small electric battery, and one end of which is enlarged and made of substantially the same shape as the opening in an eye-bathing glass, to enable it to fit the portions of the face in proximity to the eye. The claims are 3 in number.

12779. "An improved regulator combined with a portable battery for controlling the light of incandescent electric lamps used for surgical and other purposes." J. B. MEDLAND. Dated October 7. 8d. Claims:—1st. An improved regulator constructed as described, combined with a portable battery used for surgical and other purposes, for the purpose of controlling or regulating the light of an incandescent lamp or lamps sustained by the current derived from such portable battery, substantially as set forth. 2nd. The combination and use of a slide resistance regulator constructed as described, with a portable battery, composed of two, four, or more primary cells of the bichromate, Grove, or other well known type, or with secondary cells, substantially as described.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

THE last ordinary general meeting for the session of this society was held on Thursday, May 26th, Prof. J. S. HOPKINSON, F.R.S., vice-president, in the chair. The ordinary general business of the meeting having been transacted, a paper on "Underground Telegraphs," by Mr. CHARLES THOMAS FLEETWOOD, member, was read by the secretary.

In the year 1816 Mr. (afterwards Sir Francis) Ronalds laid his first experimental line underground in his garden at Hammersmith, and convinced himself at least of the practicability of establishing telegraphic communication by means of insulated wires placed beneath the earth's surface. A small book published by him in 1823, entitled, "Description of an electric telegraph and of some other electrical apparatus," gives a full account of the experiments referred to. A trough of wood about 2 inches square, well lined inside and out with pitch, was placed in a trench 525 feet long and 4 feet deep; lengths of stout glass tube were joined together by means of shorter lengths of similar tube of somewhat greater diameter, the joints being made with soft wax to allow for expansion and contraction caused by the variation of temperature. A copper wire was drawn through the glass tube, and the tube was embedded in pitch, the covering being screwed down while the pitch was hot. Mr. Ronalds further suggested that wires should be buried in iron troughs in trenches 6 feet deep in the middle of the high roads, and if there was any fear of the communication being interfered with by any mischievous person or persons, two different routes should be chosen. Testing stations should be established along the route, and linemen stationed at these points ready to start out after faults at any moment, should there be a necessity for so doing. He recommended that offices should be opened all over the country, and evidently foresaw the immense advantages that would be derived by the Government as well as by the commercial world in the employment of what he considered so "diligent a courier" as electricity.

Messrs. Cooke and Wheatstone took out their first patent in 1837 for "Improvements in giving signals and sounding alarums in distant places by means of electric currents transmitted through metallic circuits." In this patent they included a plan for laying down subterranean wires, and in the same year established communication between Euston Square Station and Camden Town by means of five copper wires let into five grooves cut longitudinally in a piece of timber, the wires being covered with cotton and passed through a preparation of resin, and after being placed in the grooves, tongues of wood were placed over them to make all secure, and the whole was then covered with pitch and buried in the earth up what is known by the railway men as "the incline" between the above-named points.

The second patent taken out by these pioneers included placing wires made up into cables in iron piping; this was in 1838. During the following year a line of five wires in an iron tube was put down on the Great Western Railway from Paddington to West Drayton, and afterwards on to Slough.

Conductors covered with cotton and passed through different solutions were tried in a variety of ways, some being suspended, and others buried in pipes, but very great difficulties were experienced in preserving the dielectrics; weak places being traced would be repaired with India-rubber tape and a solution of the same material. This kind of work was being done near the Stepney Station on the Blackwall Railway when Mr. Hatcher—then engineer to the Electric Telegraph Company—introduced to the lineman a piece of lead tubing containing several wires covered as above.

The first line of wires erected upon poles for commercial purposes was from Nine Elms to Gosport; this was before the London and South Western Railway was extended from Nine Elms to Waterloo Station. The Electric Telegraph Company opened its first office at 345, Strand, and decided to lay the wires underground from that point to Nine Elms Station. Two lead tubes about half an inch in diameter, covered with tarred yarn, each tube containing four copper wires wrapped with two layers of thick cotton, and the tube filled with a mixture of tar, resin, and grease, were drawn into a 3-inch cast-iron socket pipe. The lead tubes were originally 50 yards in length. After the wires had been joined, a piece of lead tube of larger gauge encircling the pipe was drawn over the joints and soldered at each end. A portion of this tube recently dug up was found to be in excellent condition, the tar being quite fresh.

In the year 1842 a specimen of gutta-percha was first introduced into England by Dr. W. Montgomery, but up to 1845 only a few hundredweights had been exported from Singapore. Since that date many thousands of miles of wire have been covered and buried beneath the surface of the earth, or submerged in the sea. The quantity of gutta-percha imported into London alone during the three years ended December 31st, 1886, amounted to 6,700 tons. Messrs. Keene and Nickels received a small quantity of gutta-percha from Singapore during 1845, and this appears to have been the first imported into England. This firm ultimately sold their patent for processes in working gutta-percha to the Gutta-Percha Company, Wharf Road, City Road.

During the following two years Mr. Hancock took out patents for cutting, cleansing, and pressing gutta-percha through rollers; but no mention is made of covering telegraph wire in any patent up to the end of 1847.

To Professor Faraday credit has been given of having announced that gutta-percha was an excellent dielectric, and in the beginning of 1848 patents were taken out for covering wires with it. The first patent taken out in England for this purpose, so far as I can learn, was by Messrs. Barlow and Foster, the plan suggested being as follows:—The wire was placed between two heated fillets of gutta-percha, and made to adhere by passing between two rollers. In the same year Mr. John Lewis Ricardo, chairman of the Electric Telegraph Company, patented a machine with a pair of grooved rollers, through which the wires passed, placed parallel between the fillets, the action of the rollers being to bite nearly through the gutta-percha and allow of the several wires so covered being easily separated.

These early machines did not do their work with the same regularity as those in use at the present time, for it frequently happened that instead of the covering being smooth and uniform, it was found to be thicker at intervals—so much so, that it had to be pared down with a sharp knife.

The directors of the Electric Telegraph Company having discovered that the Strand was not the best position for their chief office in London, resolved to build a central station at the end of Founders' Court, Lothbury. This was formally opened on the 1st January, 1848. From this office a circuitous line of 3-inch cast-iron socket pipes was laid, chiefly under the footways.

When these pipes were first laid down, wires covered with cotton, passed through one of the preparations in use prior to the introduction of gutta-percha, were drawn into the pipes; but these wires were soon substituted by the wires covered with gutta-percha.

The first section of line in London into which gutta-percha covered wires were drawn was from Lothbury to Shoreditch, in 1849; and this was followed by the line to Euston and King's Cross. The wires that were first drawn in were covered with gutta-percha by one of the processes already described, and failed, owing to the gutta-percha seam opening longitudinally and exposing the conductor.

At this date a large number of experiments were made: wires of iron, brass, and copper were covered with gutta-percha; in some cases single wire, in others three wires, and as many as seven wires, were enclosed in a solid core. Great improvements were rapidly introduced, and copper wire of No. 16 B. W. gauge was covered with solid gutta-percha of excellent quality up to No. 1 and 3 gauge; and by August, 1854, no less than 15 miles of pipes, containing 350 miles of wire insulated with gutta-percha, had been put into working order in London alone for the Electric Telegraph Company.

The pipes used by this company were of cast iron, 3 inches in diameter, and cast with a flat surface on one side, upon which were the initials E.T.C. Across Hyde Park the pipes were of earthenware, the joints being made with clay.

In 1850, the success of the Electric Telegraph Company induced some enterprising capitalists to form rival companies, one of which—the Submarine and European Telegraph Company—laid a line of six gutta-percha covered wires from London to Dover. This line was completed by the 1st November, 1852. In 1853 the British Telegraph Company commenced burying six gutta-percha

covered wires along the high roads from London to Liverpool, *viâ* Birmingham and Manchester, the latter place being reached by the 1st of March, 1854, and Liverpool during the same year.

The Magnetic Telegraph Company, in 1853, laid 10 wires as far as Liverpool and six wires between Liverpool and Portpatrick. Underground wires were also laid between Cork and Queenstown.

These wires were buried in a wooden troughing of about three inches outside, with a groove about 1 inch square, having a lid of the same material; this was fastened down with nails after the wires had been placed in the troughing. The iron troughing was of about the same dimensions externally, but, of course, allowed more space for the wires inside; the lids were of iron.

When cast-iron pipes were used in towns, they were very similar to the iron troughing, being cast in two pieces; they were patented by both Mr. Reid and Mr. Henley, and are known as Reid's and Henley's split pipes. The wires were in some instances laid in troughing without any protection beyond the gutta-percha, but in other cases they were protected by two layers of tarred yarn laid on in opposite directions. The whole of the stores appear to have been of the very best quality.

The underground line of the Electric Telegraph Company laid along the side of the London and North Western Railway from London to Manchester and Liverpool was somewhat different from those just described. The pipes were of earthenware, the joints being made with clay. At intervals of 50 yards split earthenware pipes of larger diameter were fixed, to allow of the wires being drawn in. An iron wire was passed through the pipes as they were being put together, for the purpose of drawing the cables through.

From London to Watford four wires only were drawn in, but these had to be increased to eight, which number was continued on to Liverpool.

The work of constructing these different systems was finished by the beginning of 1855, and, after a very short life, in 1857—58 they were condemned, and wires on poles substituted. This applied to all the underground lines laid from London to the provinces in 1853.

When the greater portion of the wires were taken up in 1857 and 1858, a few sections were allowed to remain, especially in and near London. Portions of these lines have been recovered at different periods, in different localities, and under various circumstances. Some of the gutta-percha wires that have been buried for more than thirty years are now in first-class condition, but where this is the case they have been found wrapped in two layers of tarred yarn, and laid in iron casing or split pipes. The same cannot be said of that found in wood troughing, except under special surroundings. There is every reason to believe that the gutta-percha used to cover these wires was the real material, and was not subjected to anything akin to the so-called improvements in manufacture of late years.

Although the insulating material was good, yet there were many faults in the wire previous to its being buried. Probably owing to some fault in the machinery used for covering the wire, the copper wire got elongated and pressed in the form of a loop through the gum; many such places were discovered when the wires were recovered and examined.

The wire used by the Electric Telegraph Company on the London and North-Western Railway was covered with gutta-percha, and then each wire was served with tape. After this wire was delivered on the railway at Watford, it was passed through a bath of hot tar and sand; while the drums were moving at a regular pace, a serviceable jacket of tar and sand was given to the wire, but when anything happened to interrupt the continuity of this operation the portion left in the bath was exposed to a temperature sufficient to melt the gutta-percha, and the wire passed out covered with tape, tar, and sand only. Adequate care was not exercised in protecting the wire from the heat of the sun, it being allowed to remain lying on the banks of the railway uncovered for a considerable period, so that the copper wire got out of the centre, and in some cases became exposed altogether. After the cables had been put in place, the drawing-in holes at every fifty yards were left uncovered, and the ends of the wires left exposed, waiting for the jointers to come and make the permanent joints, and the split couplings to be put on.

The means adopted to preserve the wires were defective. Knowledge derived from a series of observations points to the fact that split pipes, whether of wood or iron, are not equal to the requirements of a subterranean line of telegraph wires. Wood troughing is subject to dry rot, and therefore various expedients have been resorted to with the view of preserving the timber; but some of these preservers act injuriously upon the wire, causing the insulation to be destroyed. When the line is placed near to trees, especially oak trees, the surrounding moisture is absorbed for a considerable distance; this applies to lines constructed of either wood or split iron pipes. Special circumstances may arise that would make it expedient to use wooden troughing, but where there is an absence of such special conditions solid cast iron pipes are to be preferred. In London split pipes are a source of danger, for since the chief thoroughfares have been paved with wood or asphalte, the gas that escapes in considerable quantities from the gas companies' mains accumulates under the surface and finds its way into these half-pipes, and thence into our junction boxes, causing much annoyance and inconvenience. I have known cases where the accumulation of gas collected through split pipes has been so great that it has been necessary to open the box some minutes before the jointer could light his lamp with safety.

Where earthenware pipes have been used instead of iron, it has been done for economical reasons only. Such a line was laid some years ago from opposite St. George's Hospital, Knightsbridge, across Hyde Park, to Tyburn Gate, the joints being made with clay. Another section of the original line laid in 1851 between the site of the Exhibition of that year and the Serpentine Bridge was of earthenware. Some years ago the 16 wires that were drawn in when the line was laid, had to be drawn out to allow of the number being increased. Much difficulty was experienced in moving the old wires, and it became necessary to break one, and by laying it over the trench so to trace the locality of the obstacle; when this was done, and the ground opened, it was found that the root of a tree, about 10 feet long, had found its way through the clay with which the joints of the pipes were made, and had entwined itself round the cable in such a manner as to hold it fast. I need scarcely say that the gutta-percha had entirely perished at this point. Pipes of this description are always more liable to be damaged by the operations of the gas, water, or the hydraulic power companies' workmen when opening ground to get to their mains, than solid cast iron pipes.

Another, and I think the chief, cause of the rapid decay of the lines referred to, was the rapidity with which the work was carried out. All the companies were racing to get through to the provinces as soon as it was possible, and there is no doubt that this led to the work being done without the necessary supervision being given.

At the present time it is found necessary to place experienced men to watch the work as it proceeds, for where this has not been done the work has proved to have been unsatisfactorily carried out. When this is taken in connection with the fact that the majority of the men employed on these works were totally ignorant of the necessity of the greatest care being exercised, and the utter impossibility of the few able men to be everywhere along the works at the same time, it is not surprising that these early lines had to be so soon abandoned.

We now come to a very important epoch in connection with the telegraph systems of this country—the transfer of the telegraphs to the Post Office. This took place in the beginning of 1870, when all the different companies' lines were diverted to the central office of the Electric Telegraph Company in Telegraph Street, Moorgate Street. This work was carried out under the direction of Mr. Henry Eaton, now the superintending engineer of the metropolitan district.

After the concentration had been effected it was soon discovered that nearly all the lines, with the exception of those in solid cast-iron socket pipes, were defective in insulation; and as the various methods of construction did not provide for renewals to be carried out without opening the ground, they were gradually abandoned, and the number of wires in the 3-inch cast-iron socket pipes of the late Electric Telegraph Company increased to meet the ever-expanding requirements of the service.

Previous to the completion of the new Post Office in St. Martin's-le-Grand, in 1874, the pipes and wires passing north, south, east, and west of the new building were led through the basement and up to the instrument gallery, where they were terminated upon a very extensive test-box, the terminals being numbered from 1 to 1,000.

The contemplated change from the office in Telegraph Street having upset all the numbers in the joint-boxes in the streets, it was considered necessary to re-number the whole, and thus make the numbers in the boxes correspond with the new test-box. This was carried out so perfectly that the whole of the circuits were diverted to the new office in a very few hours on the night of January 17th, 1874, without the slightest interruption to the ordinary traffic.

At this date the length of pipes in the metropolitan district was about 100 miles, and the total quantity of wire in the pipes amounted to 3,000 miles. Shortly after this date an agitation was started against the over-house wires, and it was decided by the Post Office authorities that a new line of 3-inch cast-iron pipes should be laid down, and 100 miles of wire drawn into it, in substitution of 126 miles of over-house wire.

This was the first piece of work carried out in London with the view of reducing the over-house system belonging to the Post Office, and this was supplemented by many others, until the whole of the main lines of over-house wires had been removed.

The chief portion of this work was finished before the introduction of that marvellous little instrument the telephone, which must be held accountable for the dangers apprehended from the extraordinary network of wire suspended over the chief thoroughfares of the city, and, to a lesser extent, the suburbs of London. It has also had the effect of largely increasing the mileage of underground wire, for it was soon found that for a telephone to work satisfactorily underground, two wires must be used instead of one, and after many experiments it was found that much better results were obtained by the use of four-wire twisted cable covered with tape, two of the wires being used diagonally for the telephone circuit, thereby overcoming the effects of induction. Twenty of these four-wire cables, equal to eighty conductors, are now generally drawn into one 3-inch cast-iron pipe, some of which form part of the original lines laid down in 1847—forty years ago; and, judging from what I have seen when the wires have been drawn out for increasing, there is no reason to think they are likely to give any trouble for many years to come.

At the beginning of 1880 an experimental line of 1¾ inch wrought-iron pipe and 30 No. 18 B.W. gauge copper wires, each covered with manilla, and the whole made up into a cable and covered with a braid of the same material, was laid for the Postmaster-General, under the direction of the patentee, Mr. David Brooks, of Philadelphia.

After this line had been completed, the wires, with one or two exceptions, gave very good results as regards insulation, but from the first there was a very great loss of oil, and this continued more or less although every effort was made to trace and repair the leaks. Although the cost of construction and maintenance has been very heavy, it does appear to me that the system is worth a further trial under more favourable conditions—for instance, along a country road where it might form part of a through line, and where the pipes would not be subjected to such frequent disturbances as in the busy thoroughfares of London.

Several very large extensions to the boundary of the metropolitan district, and in some cases even beyond, as well as the enormous increase that has taken place in the supply of wires for private use, have increased the mileage since 1874 up to the present time from 100 miles of pipes and 3,000 miles of wire to 240 miles of pipes and 12,000 miles of wire, the latter being an average of 50 wires through the entire length of pipes. The total weight of copper buried in the metropolitan district amounts to over 200 tons, and that of gutta-percha to 250 tons.

It will be obvious that in the main thoroughfares near to the General Post Office the wires are very numerous. Through Little Britain there are two 3-inch pipes containing 109 wires; Aldersgate Street, two pipes, 160 wires; Gresham Street, two pipes, 150 wires; Cannon Street, two pipes, 168 wires; Cheapside, two 3-inch, one 4-inch pipes, and 242 wires; Ludgate Hill, one 4-inch, three 3-inch pipes, 350 wires; and down Newgate Street, two 4-inch, three 3-inch pipes, with over 400 wires. These numbers have been reached by gradual increments, the practice being to put into a new pipe as many wires as are actually required for the special service, with a small percentage of spare wires, and as soon as these have been appropriated for new circuits, to increase the number by drawing out the existing wires and replacing them by a cable with additional conductors. This class of work is continually being carried out in different parts of London to meet the great increase in telegraphic and telephonic business.

During the last fifteen years nearly every section of line has been disturbed, either for the purpose of removing faults which sometimes trouble us in or near the flush-boxes, through the necessarily frequent exposure of the gutta-percha to variations of temperature caused by the linemen getting new wires through, &c., or by the necessity of increasing the number of conductors as occasion may arise. So much of this work has been done that it would be difficult at the present time to point out any portion of line that has not been renewed during the above period.

The advantages of being able to replace the working wires by a greater number without seriously interrupting the communication must be evident to all; but this is easily accomplished where the lines are constructed of 3-inch cast-iron socket pipes with boxes either fixed flush with the pavement or buried beneath the surface at every fifty or one hundred yards, according to the size of the cable to be drawn in.

After many years' experience, and with a full knowledge of the many schemes that inventors have introduced from time to time, I do not know of any that can be compared with the present system for simplicity, utility, and durability.

In the discussion which followed the reading of Mr. Fleetwood's paper,

Major-General WEBBER, R.E., pointed out that the practice of adulteration of gutta-percha was one result of the great demand for the material. The underground line between Lowestoft and the cable hut, which had now been down some 20 years, when last examined, was found to be in absolutely perfect condition—this being laid at a time when adulteration had not assumed the extent it had at present. In 1878 he went to Amsterdam to examine some samples of gutta-percha; these, which were 15 in number, and varying in price from £10 to £20 per ton were all found to be mixtures. He thought Mr. Fleetwood had hardly laid sufficient stress upon the fact that to the Electric and International Company was practically due the London system of underground work, this being laid under the direction of Mr. H. Eaton, Mr. R. S. Culley, and Mr. Ship. The secret of the success of the system was the power of drawing the wires in and out of the pipes. With regard to the aerial system of the United Telephone Company he thought that capitalists ought to recognise the fact that all the wires must eventually be placed underground, and that if they commenced at once to do this, doing a little each year, then eventually the whole system would be completed at an expense which would be little felt, and at a time when the use of aerial wires would be no longer tolerated.

Mr. A. J. S. ADAMS thought that it would have been an advantage if Mr. Fleetwood had given a few more details concerning the durability of gutta-percha covered wires. He considered that if the aerial trunk lines were properly built there would be no necessity for replacing them by underground work.

Mr. W. H. PREECE thought that the object of the paper was not sufficiently appreciated. Mr. Fleetwood had given the result of his own personal experiences, and it was not to be expected, therefore, that he should have spoken of anything else. The underground work between Liverpool and Manchester, laid in 1870, had been spoken of; he would say with reference to this that it was still in use and was working properly, but the earthenware pipes, which had originally been used, had been mostly replaced by others of iron. One of the most promising systems of underground work was that being introduced by Mr. Eddison, of Messrs. Fowler & Co., Leeds; this consisted of cotton-covered wires bedded in a mixture of resin oil and other materials, and tightly enclosed in a lead pipe. Much had been said about the small amount of underground wire used in England as compared with that in other countries; but the facts were that in this country there were 25,000 miles of wire, which was 3,000 miles more than there were in Germany. There was now a proposal before Parliament to expend £2,000,000 in underground work, but it was doubtful if the amount would be authorised. It should not be forgotten that underground wires were four times as expensive as overhead wires and had only one-fourth the working capacity for fast-speed working. It was quite possible, however, that better and cheaper results might eventually be obtained. The use of secondary generators was likely to be very extensive, and the employment of these in connection with underground wires would have to be considered; such papers as that of Mr. Fleetwood went a considerable way towards assisting a solution of the question.

Mr. A. SIEMENS drew attention to the fact that in 1847 Dr. Siemens suggested the laying of an underground line insulated with gutta-percha.

Mr. EDDISON said that though the durability of lead had been questioned, he considered that this was groundless; he had a specimen of a lead-covered cable with him, which had been in a tunnel in Yorkshire for 32 years, and which was quite perfect in condition.

Mr. A. BELL said that one great fault in bitumen for insulation was its want of elasticity and the tendency to crack at low temperatures. In order to keep wires insulated with gutta-percha good the pipes ought to be thoroughly well jointed and to be deeply buried.

Physical Society, May 28th.

Prof. W. E. AYRTON, Vice-President, in the Chair.

Dr. S. P. THOMPSON read a "Note on Transformers for Electric Distribution." In the simple algebraic treatment of the dynamo several assumptions approximately true for well-made machines are made use of. The author finds that a similar set of assumptions for transformers greatly simplifies the algebraic theory.

1. The iron, copper, and insulation are assumed good. 2. The reaction of the secondary on the primary (other than that desired) is small. Thus, if the primary be supposed to be supplied with constant mean current or constant mean potential difference, this is not to be altered by the current in the secondary. 3. No magnetic leakage; so that the coefficient of mutual-induction is the geometric mean between their coefficients of self-induction. 4. The quantities of copper in the primary and secondary are to be equal. These assumptions are shown to be legitimate, and the ratio of resistances, E.M.F.'s, currents, and coefficients of self-induction are expressed in terms of the ratio of the numbers of convolutions, which ratio is represented by $p = \frac{s_1}{s_2}$. From analogy with the dynamo it is shown that $E_2 = \frac{\omega M}{\sqrt{R_1^2 + \omega L_1^2}} E_1$, where $\omega = 2\pi n$, E_1 and E_2 the E.M.F.'s of the primary and secondary respectively, and R_1 and L_1 the resistance, γ, self-induction of the primary coil. If R_1 be negligible the above reduces to $E_2 = \frac{\omega M}{\sqrt{\omega^2 L_1^2}} = \frac{E_1}{p}$, since $\frac{L_1}{L_2} = p^2$ and $M = \sqrt{L_1 L_2}$.

The latter part of the paper contains a general investigation of two neighbouring circuits both having self-induction, and it is shown that the effective resistance of the primary is increased, and the self-induction decreased by closing the secondary circuit.

Mr. KAPP said the investigations assumed the coefficient of induction to be constants, and that the phases of current in primary and secondary were opposite. The former being by no means true, he asked, what means were to be taken? and he believes the phases of current are not opposite in ordinary transformers.

Mr. SWINBURNE protested against the use of formulæ to calculate the inductions when the required data could be obtained much more accurately from Mr. Hopkinson's curves on magnetisation of iron. He also thought the curve of sines did not nearly represent the current curve for ordinary machines.

Mr. BOSANQUET thought the effective magnetisation of a transformer would be different from that of a dynamo, for in the former permanent magnetism was not utilised.

In reply to Mr. Kapp and Mr. Swinburne, the AUTHOR pointed out that as the co-efficients of induction enter in both numerator and denominator, it would not matter which set of values were taken if the resistance was small compared with ωL; and that self-induction tends to smooth out irregularities in the current curve.

Prof. AYRTON described a method of regulating a series transformer devised by himself and colleague some two years ago, based on analogy with a compound dynamo. Referring to the variation of L with current, he sketched a curve connecting them, obtained by Mr. Sumpner at the Central Institution, and mentioned that the E.M.F. curve of a Ferranti dynamo is an exact sine curve. He believes problems involving alternating currents would be greatly simplified by using a new set of measurable quantities, such as will render the equations as simple as possible.

At Prof. Thompson's request, Prof. AYRTON exhibited a lecture experiment illustrating the action of transformers. The secondarys of two ordinary induction coils were joined in series through long fine wires, and an incandescent lamp placed in the

primary circuit of one, lighted up on completing the primary of the other coil in which a battery was placed.

"On Magnetic Torsion of Iron Wires," by SHELFORD BIDWELL. This is an account of experiments made on the twisting produced by sending a current along magnetised iron wires, and the author shows that Wiedemann's explanation of these phenomena (by assuming a difference in molecular friction at the polar and lateral surfaces of magnetised molecules) is unsatisfactory. The wires were magnetised longitudinally by means of a solenoid in the axis of which the wires were suspended. To obtain consistent results it was found necessary to demagnetise the wire between the observations. This is done by reversed currents of gradually decreasing strength, and a simple arrangement of rheostat and commutator devised for this purpose was exhibited.

Two sets of experiments were made, in which the current in the wire or solenoid was kept constant whilst that in the other was varied. The amount of twisting does not increase continuously when the currents are increased but attains a maximum when the inclination of the helix, representing the direction of magnetisation, is inclined at about 33° to the axis of the wire. When the current in the solenoid was kept constant and that in the wire increased, permanent deflections remained on stopping the current. For small currents in the wire this deflection was diminished on starting the current, whilst stronger currents increased the deflection. For some intermediate value of the current no change took place (this value was dependent on the current in the solenoid). Experiments were shown illustrating these phenomena.

CORRESPONDENCE.

Secondary Generators.

The manner in which you have dealt with the communication which I have addressed to you, and the methods of discussion introduced by Mr. Kennedy, oblige me to return upon the opinion which I had of the ELECTRICAL REVIEW in considering it as an earnest journal. To the arguments which I used, to the historical facts which I referred to, Mr. Kennedy replies by treating as *farceurs* the scientists of the whole world who met at the International Congress of 1881, and considers as valueless the decisions of the international juries of Turin, 1884, and of London, 1885. I will not discuss further here his opinions, which I hope are confined to himself, but we will shortly give him an opportunity to justify the infringements for which he has rendered himself responsible before the courts.

L. Gaulard.

May 28th.

[Perhaps M. Gaulard may yet have occasion to return upon other opinions which he now holds.—EDS. ELEC. REV.]

Private House Lighting.

In the *Journal of Gas Lighting* of the 24th inst., I read with some amount of interest a criticism on an installation of electric light plant erected by the Gülcher Company, for a mansion near Petersfield, and I think in the interest of electric lighting, it should be replied to, seeing the lighting of private houses is now becoming an important branch of the business. The article implies that after an electric light installation has been handed over to the proprietor, to quote their own words, a change is apt to come over the aspect of the performance of the machinery. Now, I can point to several notable cases where installations in private houses have been running for a considerable time, perfectly satisfactorily, and in the charge of, in two instances, a gardener who had no previous training at all, and in another instance, where a housemaid has had full charge of everything.

A slight is cast also upon storage batteries; these are not used, as the article implies, in this case, to secure reliability of lighting; but to save the inconvenience that would arise by being compelled to run the engine at night. I should like to ask gas engineers how they would get on without their gas holders, which can be fairly compared to storage batteries.

In conclusion, I can only say that if private electric light installations are put down in a thoroughly good and substantial manner, with the arrangements for charging, &c., as simple as possible, and proper instructions supplied with the machinery, there is not the slightest reason why private installations should not be thoroughly reliable and quite within the control of any man with very ordinary capacities.

For THE GULCHER ELECTRIC LIGHT AND POWER COMPANY, LTD,

W. Mountain, *General Manager.*

May 28th, 1887.

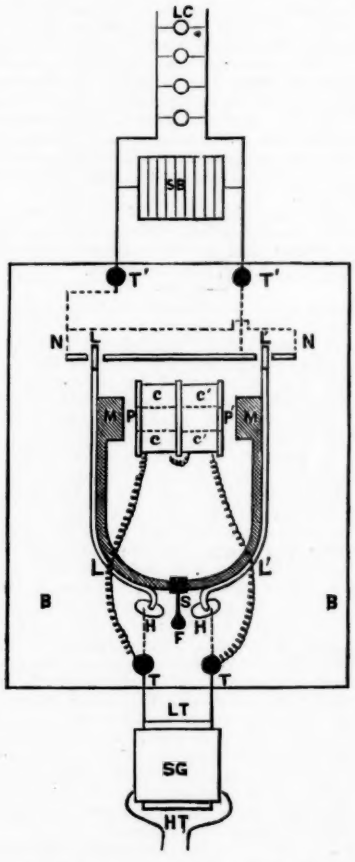
A New Form of Converter.

I enclose herewith a sketch and a description of an apparatus for converting alternating into continuous currents. I believe some such contrivance would be useful in conjunction with the distribution of energy by means of "transformers," and as such might be of interest to your readers. I do not know what degree of novelty there is in this device, but so far as I know it has not been patented.

St. G. Lane-Fox.

May 26th, 1887.

Description of the Diagram.—C, C^1, are two high resistance shunt coils connected with the terminals, T, T; they are wound round the same soft iron core, P, P^1, in such a manner that when a current passes through them the two ends of the core, P, P^1, will have the same polarity. A small fraction of the alternating current passes through these coils, and causes the magnet, M, M, to vibrate. T^1, T^1, terminals for continuous currents. L, L^1, are conductors



fixed to the vibrating magnet, M, M, and dip into mercury cups, H, H. These conductors carry the alternating currents which are to be converted into a uni-direction current. N, N represents the commutating arrangement. L, C, lamp circuit, &c., continuous current, low potential. S, B, secondary battery. M, M, permanent horseshoe magnet, supported by spring, S, and vibrating about the point F, fixed to the board, B, B. T, T, terminals for the alternating currents. L T, low tension alternating currents. S G, secondary generator or transformer. H T, high tension alternating currents from distant dynamo.